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POLAR IONOSPHERE BEACON SATELLITE (S-66)

OPERATIONS PLAN 2-63

MARCH, 1963

NASA
GODDARD SPACE FLIGHT CENTER
GREENBELT, MD.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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NASA - GSFC
OPPLAN 2-63
POLAR IONOSPHERE BEACON SATELLITE
S-66

The purpose of this Operations Plan is to provide planning information for activities concerned and to serve as a guide during the conduct of the operation. Errata and/or additional appendices will be issued as necessary.

Prepared by:
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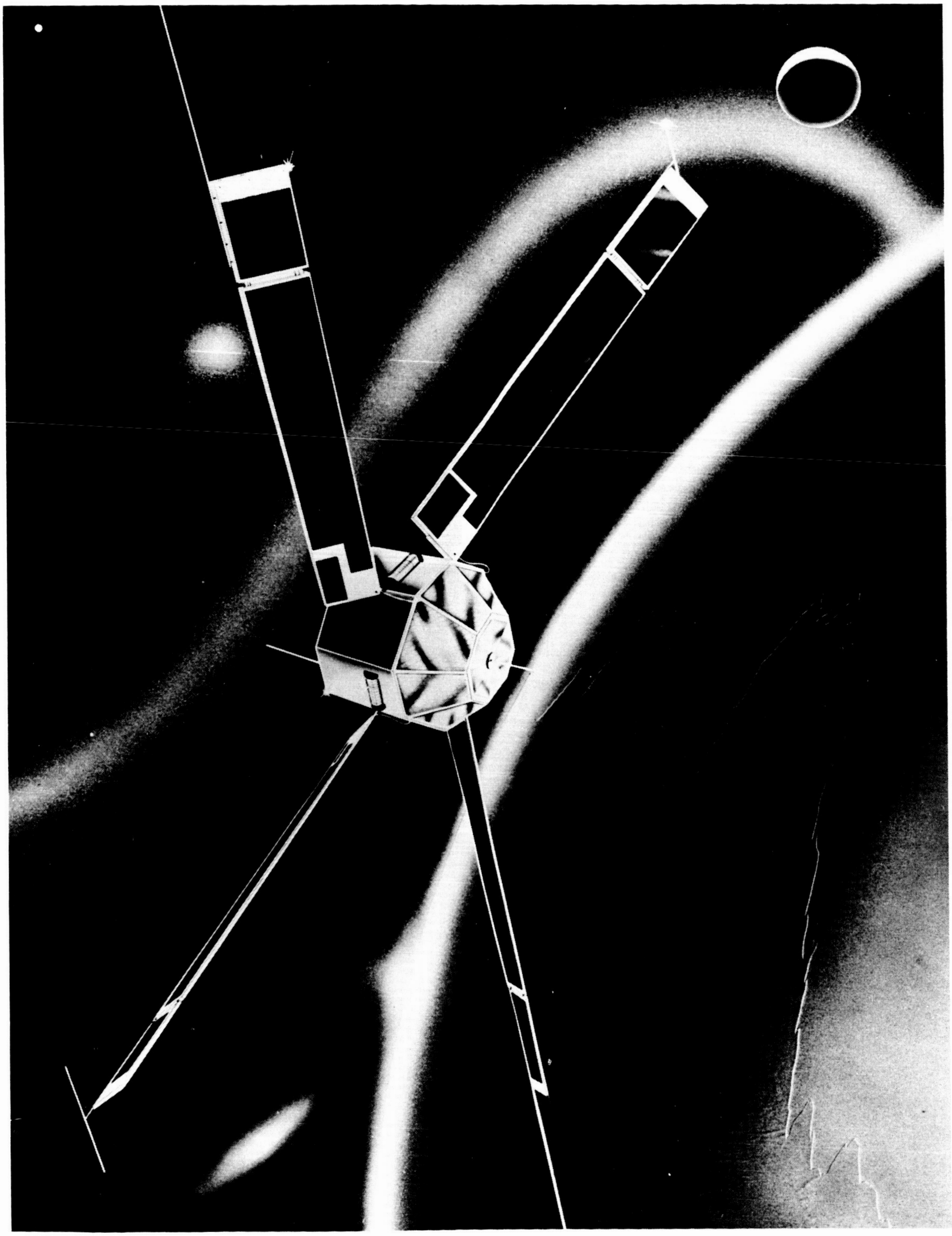
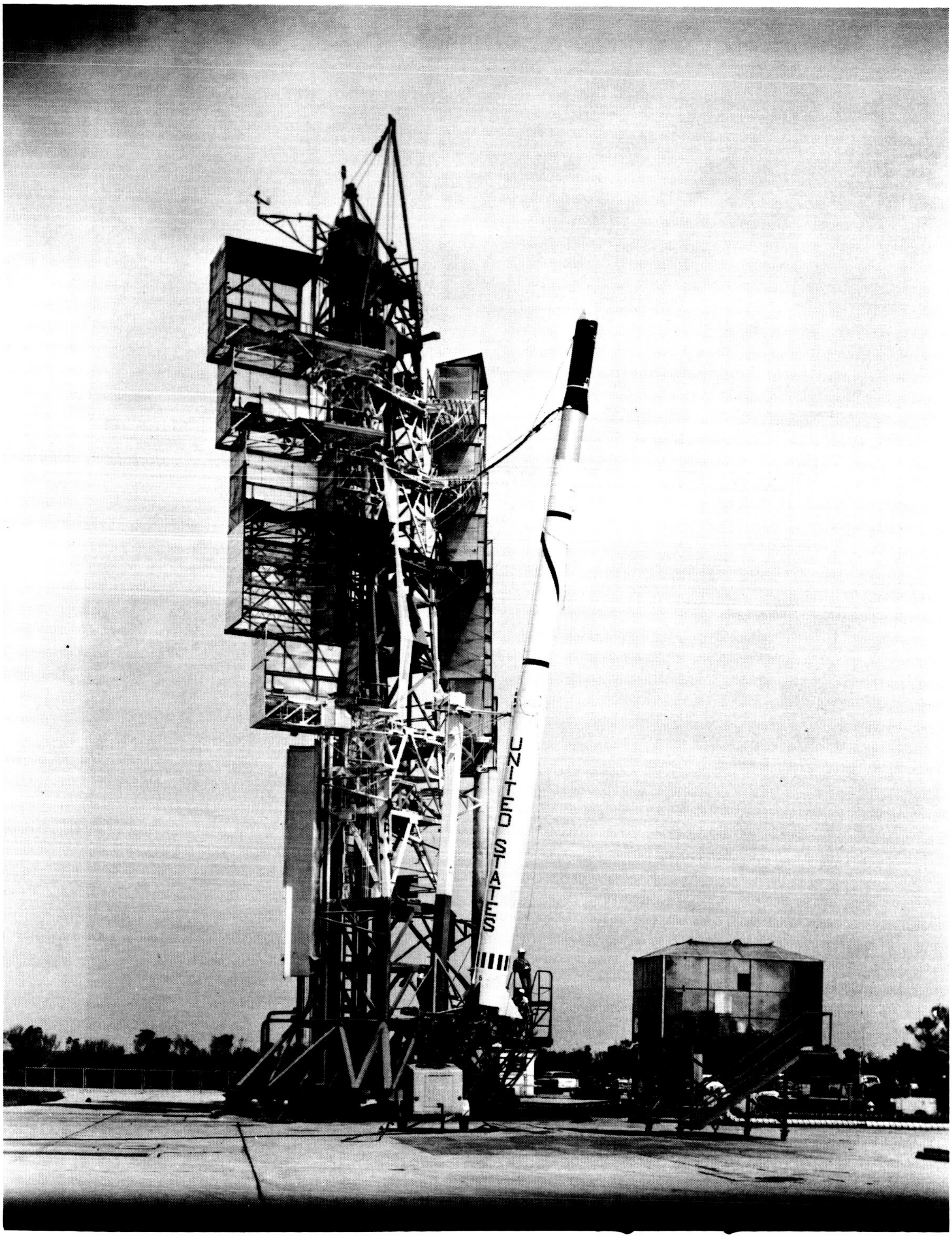
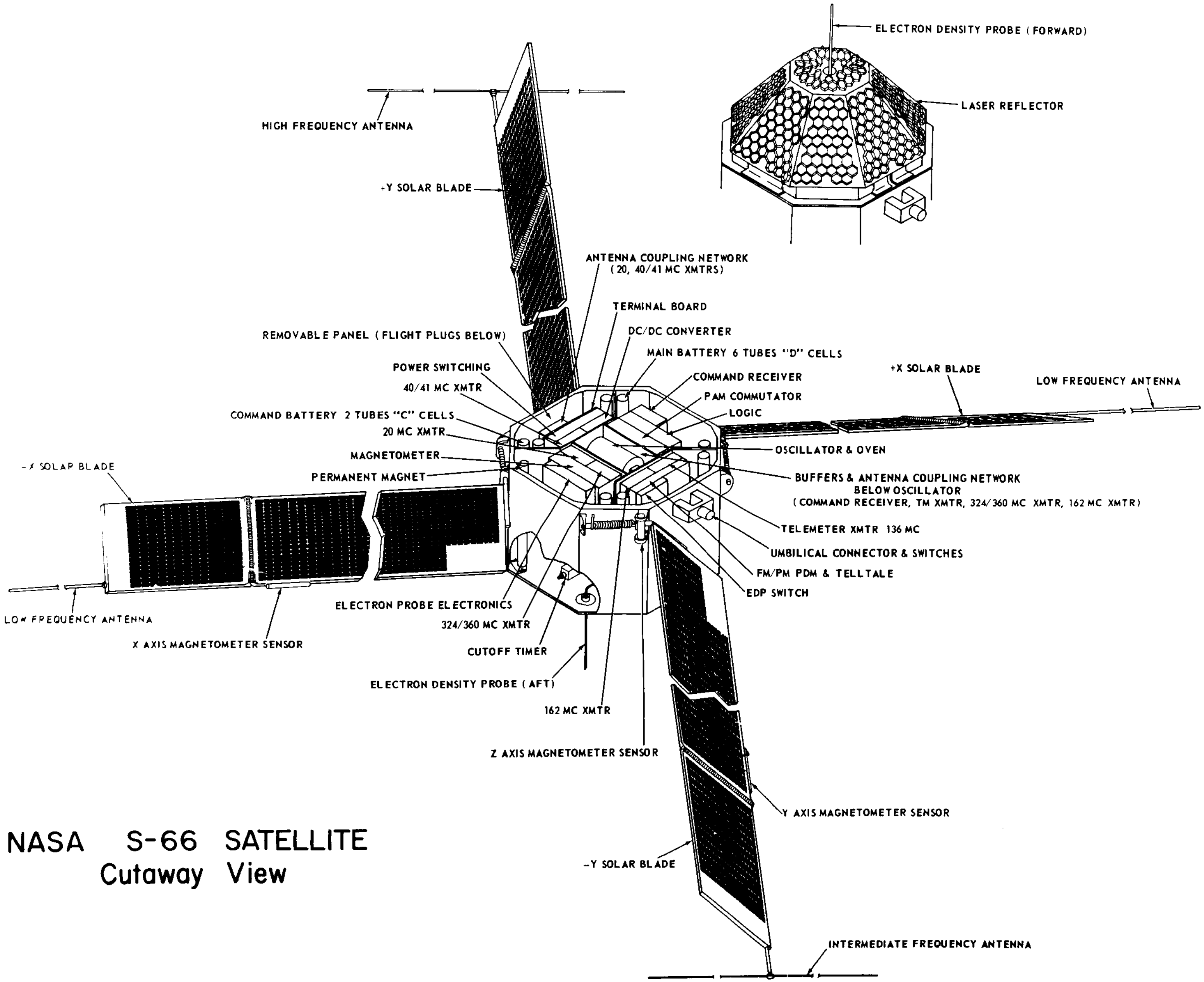


S-66 ARTIST'S CONCEPTION FIGURE 1



SCOUT LAUNCH VEHICLE FIGURE 2



NASA S-66 SATELLITE
Cutaway View

FIGURE 3

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1.0 MISSION.

The Polar Ionosphere Beacon Satellite Program, S-66, is for the purpose of ionospheric research. The S-66 program will make possible a synoptic study of the ionosphere as it varies in time and space. This program is designed to provide information on the spatial and temporal variations for the entire ionosphere. In addition, the S-66 satellite will offer a means of testing a newly devised optical tracking system by providing an efficient corner-reflector surface for ground-based lasers. The objectives of the mission are as indicated below.

1.1 To provide the means for plotting the total configuration of the ionosphere.

1.2 To determine the total electron content of the ionsophere in a vertical cross section between the spacecraft and earth under quiet and disturbed conditions, and to study its diurnal and seasonal variations.

1.3 To relate the gross behavior of the ionosphere to the solar radiation responsible for producing the ionization, and to study the effects of solar flares upon the ionosphere.

1.4 To study the geometry and occurrence of irregularities in radio-wave propagation known to exist in the ionosphere.

1.5 To test the newly devised laser tracking system.

2.0 RESPONSIBILITIES.

2.1 PROJECT MANAGEMENT.

The Spacecraft Integration and Sounding Rocket Division of the Goddard Space Flight Center has been assigned responsibility for project management of the S-66 project.

2.2 VEHICLE.

The Scout Project Office of the Langley Research Center has the responsibility for the development and utilization of the Scout vehicle.

2.3 PAYLOAD.

The Johns Hopkins University, Applied Physics Laboratory (APL), is the spacecraft contractor. As such, they are responsible for the design and construction of the spacecraft, the integration of the scientific experiments, pre-launch testing, spacecraft-vehicle integration, and post-launch monitoring of the spacecraft status.

2.4 TRACKING AND DATA ACQUISITION.

The Operations and Support Division of the Goddard Space Flight Center has the responsibility for tracking and data acquisition from launch until the termination of the active life of the tracking/telemetry transmitter or until there is no longer any scientific interest in the telemetered data.

The Johns Hopkins University, Applied Physics Laboratory, has the responsibility for tracking the S-66 spacecraft for two weeks following launch. Limited data acquisition, from launch until the termination of the active life of the tracking/telemetry transmitter, will be accomplished by APL for the purpose of establishing spacecraft status.

2.5 ORBITAL COMPUTATION.

The Data Systems Division of the Goddard Space Flight Center has the responsibility for computing and up-dating the orbit and for computing the predictions for the participating ground stations. The Data Systems Division will also be responsible for publishing orbital elements, ephemerides, and other associated data.

2.6 DATA PROCESSING AND REDUCTION.

The processing and reduction of telemetered data from the S-66 spacecraft, with the exception of the electron density information which will be a responsibility of the experimenter(s) concerned, will be a responsibility of the Space Data Acquisition Division of the Goddard Space Flight Center.

Limited processing and reduction of S-66 telemetered data in the form of quick-look status information will be a joint responsibility of the Operations and Support Division of the Goddard Space Flight Center and the Johns Hopkins University, Applied Physics Laboratory.

2.7 DATA ANALYSIS.

Data analysis of the S-66 data will be a responsibility of the various experimenters; although limited data analysis in the form of quick-look status information will be a joint responsibility of the Operations and Support Division of the Goddard Space Flight Center and the Johns Hopkins University, Applied Physics Laboratory.

3.0 ORGANIZATION.

3.1 PROJECT MANAGER - Frank T. Martin.

Mr. Martin, of the Spacecraft Integration and Sounding Rocket Division, has been designated Project Manager of the S-66 Project. In this capacity he is responsible for planning and evaluation, systems integration, systems engineering, scheduling, budgetary and financial planning and management, and project reporting.

3.2 PROJECT SCIENTIST - Robert E. Bourdeau.

Mr. Bourdeau, of the Space Sciences Division, is responsible for the over-all scientific aspects of the program. As such, he is responsible for ensuring that the maximum information is obtained from the S-66 satellite consistent with the experimental objectives of the project. He coordinates the requirements of the experimenters with those of the spacecraft system and the tracking and data acquisition system.

3.3 PROJECT COORDINATOR - John T. Shea.

Mr. Shea, of the Spacecraft Integration and Sounding Rocket Division, is responsible for coordinating the activities of the various individuals and organizations who are involved in the S-66 project. He is responsible for matters concerning the establishment, accomplishment, and modification of project schedules, and performs other functions as assigned by the Project Manager.

3.4 EXPERIMENTERS.

3.4.1 There are seven principal experimenters who will participate in the Polar Ionosphere Beacon Satellite Project. Their names and locations are as listed below.

3.4.1.1 Dr. W. J. Ross
The Pennsylvania State University
University Park, Pennsylvania

3.4.1.2 Dr. G. W. Swenson
University of Illinois
Urbana, Illinois

3.4.1.3 Mr. Robert S. Lawrence
National Bureau of Standards
Central Radiation Propagation Laboratory
Boulder, Colorado

3.4.1.4 Dr. O. K. Garriott
Stanford University
Stanford, California

3.4.1.5 Mr. L. H. Brace
Goddard Space Flight Center
Greenbelt, Maryland

3.4.1.6 Mr. L. J. Blumle
Goddard Space Flight Center
Greenbelt, Maryland

3.4.1.7 Dr. H. H. Plotkin
Goddard Space Flight Center
Greenbelt, Maryland

3.4.2 Each of the above experimenters will work closely with NASA in the ionospheric research program. Each has his own observing station or stations, and scientific program, but will coordinate his activities with the Project Scientist to accomplish the over-all objective of the mission.

3.5 GROUND SYSTEMS MANAGER - John F. South.

Mr. South is the senior representative on the project from the Tracking and Data Systems Directorate. As such, he is responsible for insuring the accomplishment of those functions which are the responsibility of the Tracking and Data Systems Directorate. In his capacity, Mr. South has available the advice and assistance of various scientists, specialists, and technicians within the Tracking and Data Systems Directorate.

3.6 OPERATIONS COORDINATOR _ Frank J. Lawrence.

Mr. Lawrence is a member of the Tracking and Data Systems Operations Branch. He works closely with the Ground Systems Manager to insure that those phases of the project which are the responsibility of the Operations and Support Division are completed as required. He is responsible for the preparation and distribution of the official GSFC Operations Plan.

3.7 DATA SYSTEM SCIENTIST - D. Stewart.

Mr. Stewart, of the Data Systems Division, is responsible for coordinating the computation of the satellite's orbit, the preparation of tracking and data acquisition predictions, analyzing present orbital programs to ensure that they are capable of computing the necessary parameters associated with the S-66 spacecraft, the preparation of the GSFC Prediction Bulletin, and the preparation of ephemerides as required.

3.8 DATA PROCESSING MANAGER - D. A. Parker.

Mr. Parker, of the Space Data Acquisition Division, is responsible for initiation and formulation of the plans for equipment, development, and data processing operations, and for performing the ultimate data reduction in accordance with the requirements of the project.

3.9 VEHICLE COORDINATOR - A. B. Churgin.

Mr. Churgin, of the Langley Research Center, is responsible for assuring compatibility between the payload and the Scout launch vehicle, that the orbit will satisfy the experimental requirements of the project, and that the vehicle is on schedule.

4.0 PROJECT IMPLEMENTATION.

4.1 VEHICLE.

4.1.1 Vehicle Description.

The Scout launch vehicle (Figure 2) is a four-stage solid-fuel rocket system manufactured by the Chance-Vought Corporation. The propulsion motors are arranged in tandem, with transition sections between the stages to tie the structure together and to provide space for instrumentation and controls. The complete configuration is 72.58 feet long with a body diameter of 3.33 feet.

4.1.2 Stages.

The four solid propellant stages of the Scout launch vehicle are as follows:

First Stage	An Aerojet Jupiter Sr. 2A "Algol" motor.
Second Stage	Thiokol's XM 33 E5 "Castor" motor.
Third Stage	An Allegany Ballistics Laboratory X-259 A1 "Antares" motor.
Fourth Stage	An Allegany Ballistics Laboratory X-248 A5 "Altair" motor.

4.1.3 Guidance and Control System.

The guidance system consists basically of three miniature integrating gyros (MIG's), which provide the reference for each axis, three rate gyros (GNATS), and a pitch axis programmer.

During first stage burning, the vehicle, which is aerodynamically stable in the lift-off configuration, is controlled by a proportional control system which features a combination of jet vanes and aerodynamic-tip control surfaces. The jet vanes provide most of the control force during the thrust period while aerodynamic-tip controls provide all the control force during the coast period following first stage burnout.

To be supplied at a later date.

NOMINAL ORBIT SUB-SATELLITE PLOT

S-66 POLAR IONOSPHERE BEACON SATELLITE

FIGURE 4

After first stage separation, the succeeding configurations are no longer aerodynamically stable. During second and third stage burning the vehicle attitude is controlled by sets of hydrogen peroxide reaction jets. The fourth stage, which has no active guidance or control system, receives its initial spatial orientation from the control exerted by the first three stages, after which it is spin stabilized to 160 rpm $\pm$ 10 percent by means of three small rocket motors mounted on the skirt at the base of the fourth stage.

4.2 ORBIT.

4.2.1 Trajectory.

The Scout launch vehicle will be launched in a vertical position from the launch complex at the Pacific Missile Range, Point Arguello, California, with a range heading (azimuth) of approximately 173°.

4.2.2 Orbital Characteristics.

The following are the nominal orbital elements for the S-66 spacecraft.

Apogee	930 Kilometers
Perigee	930 Kilometers
Inclination	80$\pm$2 Degrees
Period	105 Minutes (Approximately)

A sub-satellite plot of the S-66 orbit can be found in Figure 4.

4.2.3 Orbital Lifetime.

The expected useful lifetime of the spacecraft is nominally three years. This period may be extended if optimum spacecraft performance is achieved.

4.3 SPACECRAFT.

4.3.1 General Description.

The external configuration of the S-66 satellite will be in the shape of a right octagonal prism measuring approximately 18 inches across flats and 12 inches high (Figures 1 and 3). The side and end panels will be a honeycomb sheet metal sandwich construction with appropriate inserts for local strengthening and fastener support. At the center of the structure, extending from top to bottom panels, is a sheet metal rectangular box which forms the backbone or main load bearing member of the structure. The dual oscillator package is housed in this rectangular box and the modular electronic packages or books are fastened to the sides of the rectangular central structure in cantilever manner. Batteries are contained in tubes which are bolted to the supporting ribs which extend from the outer shell to the central rectangular box. High-heat dissipation packages will be fastened to the inner wall of the base plate which acts as a radiator to dissipate excess heat. The present weight estimate for the satellite is 114 pounds.

Located on four 6 by 66 inch blades will be solar cells and antennas to cover three basic transmitting systems: the NASA Ionospheric Beacons at 20, 40, 41, and 360 Mcs; the APL Doppler system at 162 and 324 Mcs; and the telemetry transmitter at 136.170 Mcs. The outer 18 inches of each blade folds back against the inner 48 inch section in the launch configuration. Upon injection into orbit, the blades will unfold to assume a pitch appropriate to provide the power generating characteristics for the particular orbit inclination. The panel structure is planned to be of a very light sheet metal assembly in which a corrugated core is fastened between two flat skins. This provides an assembly of sufficient rigidity and strength at a significant weight saving over the more conventional honeycomb construction.

4.3.2 Despin Systems.

The S-66 satellite will utilize a mechanical despin (yo-yo) device to reduce the 160 rpm nominal spin rate of the fourth stage and payload down to 40 rpm.

When the despin weights are released, erection of the solar cell blades is initiated. The resulting change in the spin axis moment of inertia reduces spin rate from 40 rpm to 10 rpm. This residual spin rate will then be reduced virtually to zero by means of magnetic despin rods contained within the satellite blades. The rate at which the satellite despins can be controlled by varying the number and weight of the magnetic despin rods. S-66 contains four despin rods composed of magnetic material which will remove residual spin in 3-5 days.

4.3.3 Power Supply.

The power system for the S-66 satellite will employ solar cells charging a bank of nickel-cadmium batteries. The solar cell power system is divided into four separate circuits; main 24 volt circuit, boost 24 volt circuit, command receiver circuit and active temperature control circuit. The solar cells are mounted on four blades which fold around the fourth stage of the launch vehicle in the launch configuration and extend outward from the satellite upon payload separation.

The S-66 solar array has approximately 100 percent initial power margin over the load requirements. Total power load will be 13.25 watts maximum.

To prevent severe overcharging of the nickel cadmium batteries due to the large initial power margin, the 24 volt circuit is divided into two parts -- main and boost. The boost circuit can be switched in by command. The maximum charge current of the main circuit, averaged over a complete orbit, is within the overcharge capability of the cells comprising the 24 volt battery. After the solar cells have degraded to the point that it is necessary to switch in the boost circuit, the total charge current will again be within the overcharge capability of the battery.

The initial power margin in the command receiver circuit is also approximately 100 percent. The command receiver battery is capable of withstanding the resulting overcharge and no switching is required.

4.3.4 Ionosphere Beacon Transmitter.

The ionosphere beacon transmitter system consists of four unmodulated CW transmitters operating continuously at 20, 40, 41, and 360 Mc. from a single ultrastable crystal oscillator operating at a frequency of 5 Mc. plus 250 ppm (5.00125 Mc).

The crystal and oscillator electronics are mounted in a multiple Dewar flask with active temperature control. These transmitters are designed for maximum short-term (15 minutes) amplitude and frequency stability, and for minimum differential-phase jitter (i.e., phase coherence will be kept as high as possible to maintain the transmitted frequencies at exact ratios of 20, 40, 41, 360 Mc.). Power outputs and output stability for the beacon transmitters are:

Frequency (Mc)	Power (mw)
20	250
40	250
41	250
360	100
Amplitude stability	drift less than 2 db/10 minutes
Frequency accuracy	$\pm 0.005\%$
Relative phase jitter of any one transmission with respect to any other.	less than 1 radian in periods of 2 seconds to 1 minute.
Short-term (1 sec) noise	less than 2×10^{-10}
Drift	less than 10^{-9}/hour less than 10^{-8}/day

A "clock marker" or timing pulse will appear on the 20 Mc signal. This modulation will be a rectangular pulse 1/10 sec. wide and will occur every 22.0185 seconds with an accuracy of 0.01 percent. The power reduction will be 3 db. The signal for the timing mark will be derived from a tuning fork oscillator with a stability of 1 part in 10^9.

4.3.5 Attitude-Control System.

4.3.5.1 Magnetic Attitude Control.

A strong magnetic dipole mounted internally in the satellite will stabilize the spacecraft's symmetry axis along the local direction of the earth's magnetic field. There will be one magnet about 3/4 inch in diameter and 12 inches long. The total weight of the magnet is 1.8 lbs.

The use of this system for stabilizing satellites offers several advantages; it is completely passive, light in weight, and extremely reliable.

4.3.5.2 Attitude Detectors.

Two systems of attitude detectors will determine the attitude of the satellite with respect to the sun and with respect to the earth's magnetic field. The solar attitude-detection system consists of four solar cells calibrated to provide directional data, from their analog voltage output, for measuring the attitude of the spacecraft relative to a line from the sun. These detectors also will provide information on the spacecraft's spin rate and on solar-cell deterioration.

A light weight flux gate, three-axis, magnetometer will be used to determine spacecraft orientation relative to the earth's magnetic field.

The magnetometers carried in the S-66 satellite will be used to measure the intensity of magnetic storms; this data may prove useful in correlating magnetic storms with ionosphere data derived from the refraction and Faraday rotation of radio signals transmitted from the satellite.

4.3.6 Thermal Design.

The S-66 spacecraft will provide a controlled thermal environment over large thermal variations which may occur during the course of the year because of the motion of the orbital plane relative to the sun. These conditions may vary from approximately 60 percent to 100 percent exposure to sunlight. Variations in the thermal input to the main structure are reduced to an acceptable level in the S-66 spacecraft by the magnetic attitude-stabilization control system, and by the proper choice for spacecraft configuration (i.e., designed so that the satellite's area projected to the sun will be maximum in the 60 percent sunlight orbits and minimum in the 100 percent sunlight orbits).

The thermal design of the spacecraft is further simplified by mounting the solar cells on blades whose temperature is controlled by providing adequate heat transfer through the blades, so that the back serves as a radiator whenever the front is illuminated. The entire surface of the solar blade can be treated with either absorptive or reflective substances.

The satellite also contains an automatic temperature control (ATC) system. This system is designed to maintain the satellite instrument packages at a constant temperature of plus 60 degrees F. This technique is made possible by the use of an on-board power system which closely controls the amount of electrical power dissipated in the satellite, and a coating pattern on the outer shell which minimizes the variation of mean shell temperature with percent sunlight exposure. This arrangement in conjunction with a thermal resistance from interior to exterior of about 5 degrees F per watt will allow the internal temperature of the satellite to be controlled with the addition of a modest amount of power. The physical arrangement of this system consists of eight small packages distributed in a symmetrical manner around the instrument packages, each consisting of a mercury-in-glass thermostat, a transistor switch and its biasing and load resistors. These components are encased in a small magnesium case. The total weight of these eight packages is less than 0.4 pounds.

The ATC system is powered by solar cells that are in a small array on each side of each blade structure. These arrays are connected in parallel through diodes to prevent the cells that are illuminated from discharging through the cells that are not required in this system since the thermal capacity of the instrument structure acts as the energey storage device during the time that the satellite is in the earth's shadow. This solar array supplies an average power of approximately 4 to 6 watts with all of the thermostats in the "ON" condition. This system is purposely designed to be redundant so that a failure of a single package will have very little effect on system operation, since most of the time the duty cycle of the remaining heater units will merely adjust to maintain the temperature at a constant level. The solar power system is also quite reliable, since each array is isolated by the diodes.

4.3.7 Telemetry System.

4.3.7.1 General.

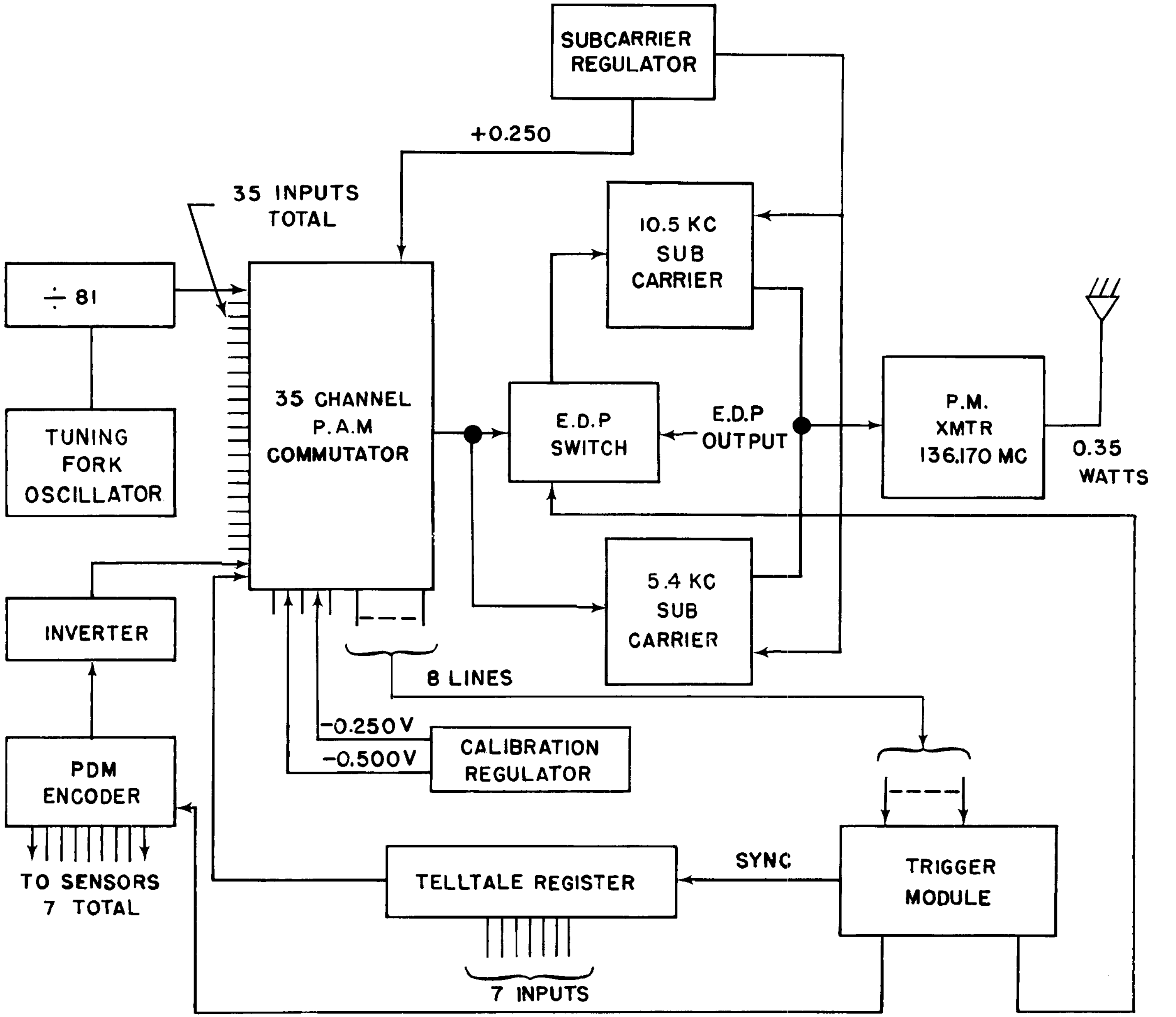
The S-66 telemetry system (See Figure 5) consists of a phase modulated (PM) transmitter, two voltage-controlled oscillators, a 35 channel pulse amplitude modulation (PAM) commutator, an 8 channel pulse duration modulation (PDM) commutator, and 7 telltale register functions with pulse coded modulation (PCM) format. Figure 6 shows a simplified block diagram of the S-66 telemetry system.

The phase modulated transmitter has a nominal output power of 350 milliwatts at a carrier frequency of 136.170 Mc. and will be modulated by the combined outputs of two subcarriers. The peak pulse deviation will be 80° with each of the two subcarriers contributing an equal amount or 40°. The output of the subcarriers is sinusoidal. The sub-carriers are frequency modulated and deviate $\pm$ 6 percent for an input voltage of ± 0.25 volts for the 5.4 Kc sub-carrier and 0 to -0.5 volts for the 10.5 Kc sub-carrier. The two sub-carriers have their inputs tied in parallel and therefore they will have the same information impressed on their inputs. However, every eighth frame of the 35 channel commutator, and for the duration of that frame, the electron density probe switch will change state so that the electron density probe experiment will read out on the 10.5 Kc subcarrier. Following the completion of this frame, the electron density probe switch will return to monitoring the output of the 35 channel commutator.

The sub-carriers normally recieve their input from the 35 channel PAM commutator. Functions to be telemetered are listed in Table 4-1. The PAM commutator operates with a 75 percent duty cycle. The time for a sample including dead time will be approximately 0.629 seconds. The sample time is controlled by a tuning fork operating at 515 cps. This frequency is scaled down by a factor of 81 before being fed to the PAM commutator. A PDM encoder is synchronized with channel 1 of the 35 channel PAM commutator and will make seven temperature measurements during each frame of the 35 channel PAM commutator. An inverter is required between the PDM encoder and the 35 channel commutator to convert the positive going output of the PDM encoder to a negative going output that is compatible with the 10.5 Kc sub-carrier. A telltale register is synchronized with channel 9 of the 35 channel PAM commutator and will read out seven pieces of ON/OFF type information.

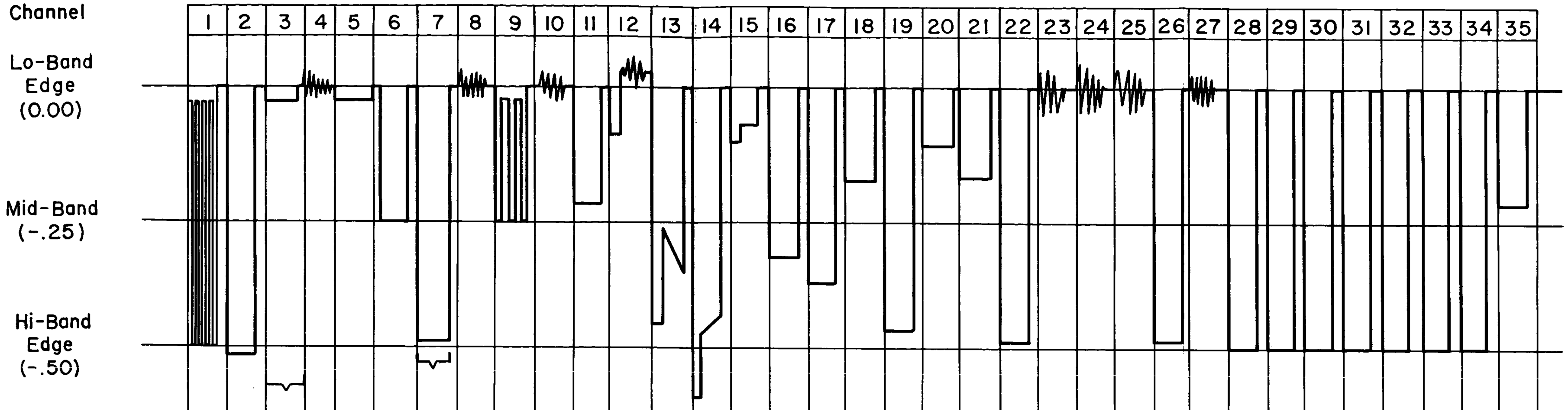
4.3.7.2 Antenna System.

The antennas for the 20 Mc., 40 Mc., and 41 Mc. transmissions are whip antennas, 5 feet long, at the end of two oppositely oriented satellite blades. A dipole, mounted at the end of one of the other blades and oriented so that the dipole is parallel to the whip antennas, will radiate the 162 Mc. and 136 Mc. transmissions. On the remaining fourth blade another dipole, also oriented parallel to the whip antennas, will radiate the 324 Mc. and 360 Mc. transmissions. The command receiver antenna will be an 18-inch quarter-wave whip extending from the base of the satellite on the side opposite from the electron density probe. A coupling network will isolate the respective antennas and minimize antenna coupling losses.



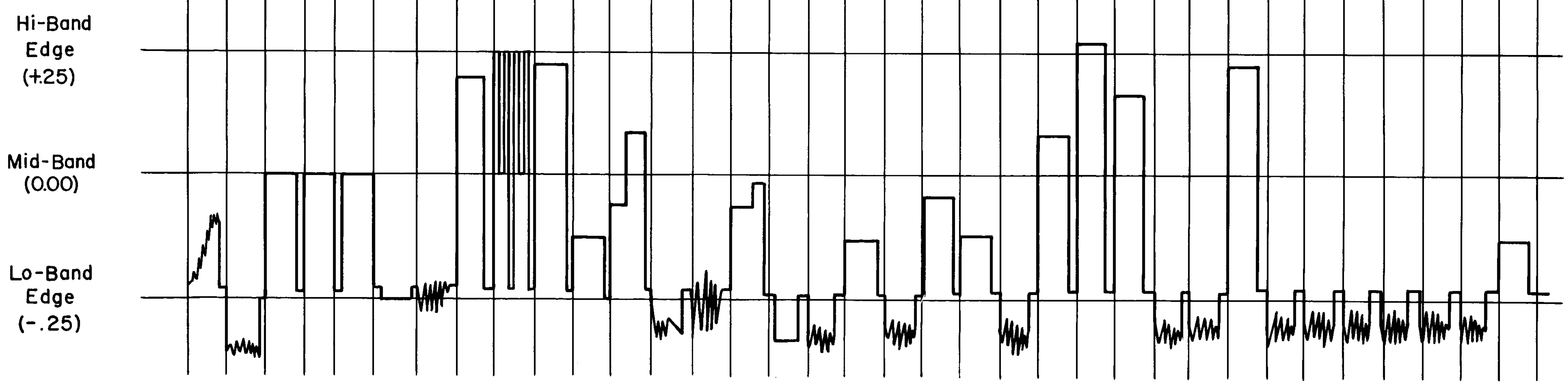
BLOCK DIAGRAM-S-66 TELEMETRY SYSTEM

FIGURE 5



Output Format for 10.5 kc Discriminator

FIGURE 6a



Output Format from 5.4 kc Discriminator

FIGURE 6b

TABLE 4-1

TELEMETRY ASSIGNMENTS

MAIN COMMUTATOR (PAM)

CHANNEL ASSIGNMENT	FUNCTION
1	PDM
2	3 mc Oscillator Regulator
3	5 mc Oscillator Regulator
4	+0.250 Volt Calibrate
5	0.000 Volt Calibrate
6	-0.250 Volt Calibrate
7	-0.500 Volt Calibrate
8	Separation Telemetry/ Magnetometer Reg. Voltage
9	Telltale Register
10	Active Temperature Control Voltage
11	Active Temperature Control Current
12	X Magnetometer (Direct)
13	Y Magnetometer (Direct)
14	Z Magnetometer (Direct)
15	Z Magnetometer (Attenuated)
16	Cosine Solar Elevation Detector
17	Linear Solar Elevation Detector
18	+X Solar Azimuth Detector
19	Solar Attitude Calibrate
20	+Y Solar Attitude Detector
21	-Y Solar Attitude Detector
22	Receiver #1 AGC Voltage
23	Command Battery Current
24	Main Solar Charge Current
25	Load Current
26	-24.3 Battery Voltage
27	-10.7 Command Voltage
28	Blade Erection/ +21.4v Converter Voltage
29	20 mc Transmitter Power
30	40/41 mc Transmitter Power
31	136.17 mc Transmitter Power
32	162 mc Transmitter Power
33	324 mc Transmitter Power
34	360 mc Transmitter Power
35	Receiver #2 AGC Voltage

SUBCOMMUTATOR #1 (PDM)

(Appears on Channel 1 of the main commutator)

CHANNEL ASSIGNMENT	LOCATION
1	Osc. Oven Case
2	Calibration
3	PDM Book
4	Command Battery/ Separation Switch
5	Main Battery
6	+X Solar Array
7	Base Plate
8	Outer Shell (-Z)

SUBCOMMUTATOR #2 (PCM)

(Appears on Channel 9 of the main commutator)

CHANNEL ASSIGNMENT	FUNCTION
1	Oven Current
2	Charge Regulator
3	20, 41/41 and 360 mc Transmitters
4	162,324 mc Transmitters
5	Solar Boost
6	Active Temperature Control
7	Electron Density Probe

4.3.8 Command System.

4.3.8.1 General.

A command logic is employed in the S-66 satellite to perform certain switching functions by means of ground command, i.e. turn the transmitters "ON" or "OFF", provide a means for disconnecting the batteries from the solar power supply, and for disabling the active temperature control systems.

The command logic is drived from the outputs of two command receivers, operating with either or both receivers functioning, and drives into the satellite power switching in such a manner to control two pairs of satellite commands in logical sequences. A block diagram of the satellite command logic is shown in Figure 7. The 2 channels provide for a 6 X 8 or 48 conditions of satellite operation.

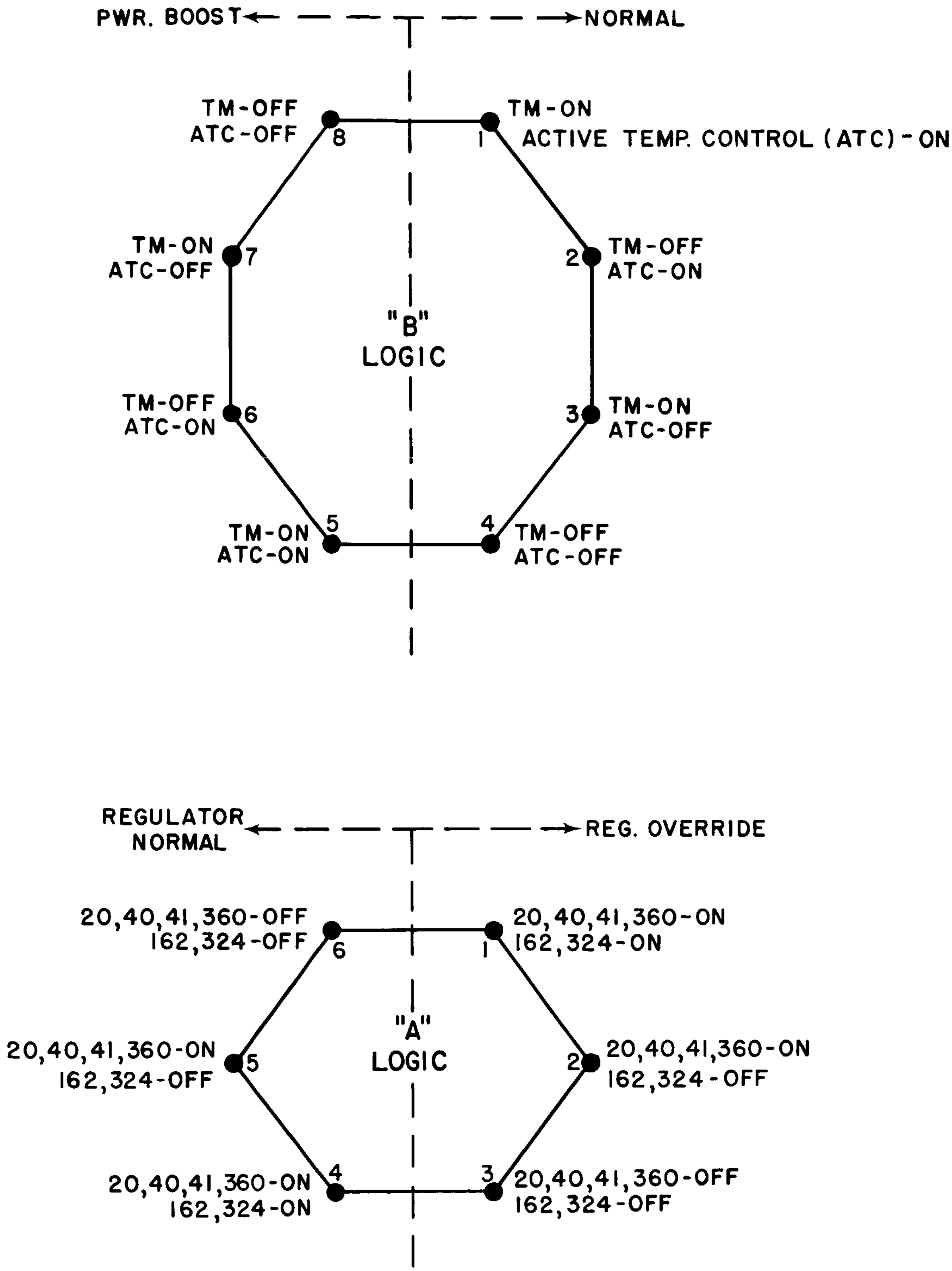
In addition to the command function of the logic, a hold control for the satellite commutator is provided to allow prolonged (nominal 100 sec.) examination of any of the commutator telemetry channels. Each time command "C" is transmitted to the satellite, the commutator will stop upon completion of that command. If no commands ("A" or "B") are received for the next 100 seconds the commutator will remain on the channel that was being transmitted when command "C" stopped. After 100 seconds a timer in the satellite will start the commutator running again with no signal from the ground. However, should commands "A" or "B" be transmitted within this 100 seconds the commutator will begin running as soon as the command logic recognizes the presence of the command. The commutator will pick-up in the sequence where it left off, i.e., should the commutator be stopped on channel 12, then when the commutator starts it will proceed to 13 and continue in normal fashion.

4.3.8.2 Commands.

The commands that will be used for commanding the S-66 satellite are listed in Table 4-4.

TABLE 4-4

COMMAND	FUNCTION
"C"	Energizes the spacecraft command logic.
"A"	Steps channel "A" selector switch one step forward (clock-wise) for each command pulse.
"B"	Steps channel "B" selector switch one step forward (clock-wise) for each command pulse.



BLOCK DIAGRAM - COMMAND LOGIC

FIGURE 7

The command sequence is initiated by the transmission of command "C" for a pre-set interval to "open" the satellite. Then either commands "A" or "B" can be sent to operate one of the two switching systems incorporated in the satellite.

NOTE: All frequencies will be transmitting continuously from launch through normal satellite operations. Commanding the S-66 satellite will be only to exercise portions of the payload during the early orbit phase or to de-energize portions of the payload in the case of a malfunction.

4.4 EXPERIMENTS.

4.4.1 Ionosphere Experiments.

The S-66 Polar Ionosphere Beacon Satellite is intended to provide a means for obtaining Faraday rotation and differential Doppler ionospheric measurements over most parts of the globe over an extended period of time.

The ionospheric measurements radio-frequency system will have four coherent unmodulated CW transmitters, and will radiate at power levels over 100 mw to insure good signal-to-noise ratios. The radiated frequencies will be 20.005 Mcs, 40.010 Mcs, 41.010 Mcs, and 360.090 Mcs, all harmonics of 1.00024 Mcs.

4.4.1.1 Basis of Measurements.

In traversing a magnetoionic medium, a plane wave undergoes a rotation of its plane of polarization; the total angle-of-rotation depends on the average magnetic-field component in the direction of propagation, and on the total number of electrons in a column one square meter in cross section along the propagation path. As a satellite moves, a time-variation of the total angle of rotation occurs, which is reflected as a continuous rotation of the electric vector at the receiving point. The magnetic field of the earth is known to the desired accuracy; therefore, the total angle-of-rotation along the transmission path determines, approximately, the columnar electron content along the path. Generally, it is not possible to measure the total-angle-of rotation; instead, the rate of rotation and the number of complete rotations between two points on the orbit are determined.

Three methods of measuring Faraday rotation have been devised for use in data collection and in data analysis. Ground receiving stations may utilize the single-frequency method, the second-order Faraday rotation method, or the closely spaced-frequencies method for ionospheric studies.

4.4.1.1.1 Single-Frequency Method.

Measurement of the rate of change of the polarization angle at a given instant yields an approximate determination of the electron content. Theoretically, a determination can be made for a given instant of time; in practice, however, the number of revolutions of the electric vector must be measured in a finite time in order to accurately determine the rate. This rate-of-rotation method is probably the simplest means of obtaining an approximation of the electron content of the ionosphere. This method, however, has errors induced into the formula by neglecting the vertical component of velocity and the horizontal variation of the ionosphere. As the S-66 satellite will be in a high circular orbit, the effects of neglecting the vertical component of velocity are minimized; also, in this method, it is assumed that the frequency is high compared with the maximum critical frequency of the ionosphere, and that the ray path is a straight line. These assumptions indicate the possibility of limited accuracy with this method.

4.4.1.1.2 Second-Order Faraday Rotation Method.

Corrections can be made for the high-frequency approximation and for refraction by using two widely separated frequencies and reducing the data by means of second-order formulas. It is convenient for this purpose to use two harmonically related frequencies; in the S-66 satellite, 20 and 40 Mc will be used. The use of these methods indicates that the errors caused by refraction and the high-frequency approximation are in the neighborhood of 5 percent for close passages and up to 30 percent for distant passages.

4.4.1.1.3 Closely Spaced-Frequencies Method.

The use of two closely spaced frequencies permits an unambiguous determination of the total angle through which the electric vector is rotated in traversing the ionosphere; in the S-66 spacecraft, 40 and 41 Mc will be used.

By using plane-polarized antennas and receivers with logarithmic-amplitude response, records such as those shown in Figure 8 will be obtained. It is most convenient to count in terms of complete revolutions, as indicated by nulls in the pattern; a null occurs every half-revolution. The differential angle-of-rotation between the two frequencies is measured, and with this the total electric vector rotation is calculated.

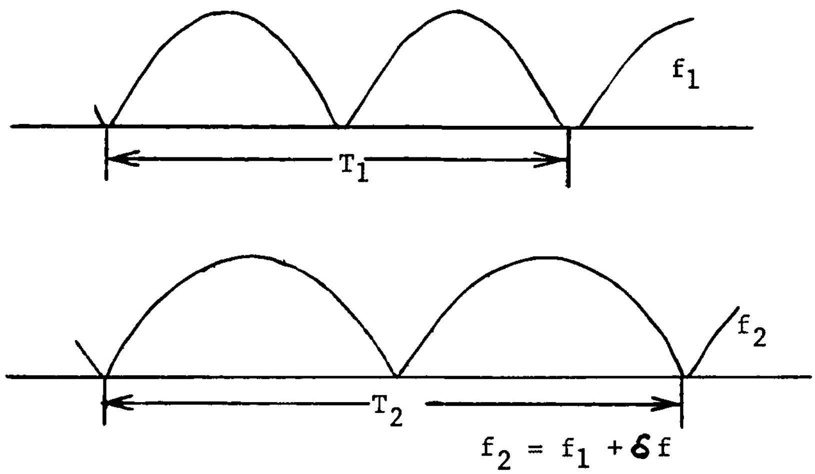


Figure 8

Typical Received Signal Using Closely Spaced Frequencies Method

The principal advantages of this method are simplicity of data reduction, and the ability to make an unambiguous measurement of integrated electron content in a relatively short interval of time.

4.4.1.2 The Doppler-Shift Method of Measuring Integrated Electron Density.

The high velocity of a satellite relative to a ground-based observer results in a substantial Doppler shift in the observed frequency. In the ionosphere, the phase velocity depends upon the electron density; thus, the observed frequency depends upon the electron content. Observation of the exact frequency as a function of time can be used to determine the electron content of the ionosphere.

To determine the effect of the ionosphere on the Doppler shift, it is necessary to know the Doppler shift that would occur in the absence of the ionosphere. This, in turn, implies an accurate knowledge of the orbit and of the radiated frequency of the satellite. A more convenient technique is to observe two frequencies radiated by the satellite chosen so that one is strongly affected by the ionosphere, and the other is so much higher than the critical frequency corresponding to the maximum electron density that is relatively free of ionospheric influence. As the frequency ratio between the two signals must be known precisely, it is convenient that one be a harmonic of the other. Frequencies selected for this purpose on the S-66 spacecraft are phase-locked signals on 20 Mc, 40 Mc, and 360 Mc.

A separate superheterodyne radio receiver is used for each frequency. An additional beating oscillator is provided which has phase-locked outputs near 20 and 40 Mc, and these outputs are injected into the RF-input terminals of the respective receivers. The 40 Mc receiver's beat frequency is approximately twice that of the 20 Mc receiver. Next, the beat note of the 20 Mc receiver, multiplied in frequency by a factor of 2, is mixed with the beat note from the 40 Mc receiver; the "difference frequency", selected by means of an appropriate filter, is low enough to be recorded directly on a graphic record.

4.4.1.3 Electrostatic Probe Experiment.

An electrostatic probe is an electrode of suitable geometry that is immersed in the ionosphere (a plasma) for the purpose of measuring properties of the charged-particle region. In the case of S-66, a sawtooth voltage is applied alternately to two small cylindrical probes which extend into the plasma surrounding the spacecraft. Two independent solid state current detectors are used alternately to resolve the probe currents over the expected range of electron densities. The resulting collected currents are detected and converted to a form suitable for telemetering to the ground. Telemetry readout of the probe data will occur once during every eight frames of the PAM readout cycle; i.e. 22 seconds out of every 168 seconds, electron density probe data will be telemetered.

4.4.2 Laser Tracking Experiment (GSFC).

The S-66 spacecraft will be used to test a new optical tracking system. Equipment for the test will consist only of the corner-reflector assembly shown in Figure 3.

A passive optical laser reflector will be mounted on the forward face of the satellite. The unit will consist of eight sloping trapezoidal panels and one octagonal pyramid. The panels are composed of honeycomb aluminum material.

Each of the nine panels is covered with a mosaic of 40 cube corner prisms. The prisms are constructed of quartz (fused silica). The front faces of the prisms are hexagonal shaped. The reflecting surfaces of each prism consists of three aluminized plane faces, perpendicular to each other, within a tolerance of 3 seconds of arc.

A light ray impinging on the hexagonal shaped top face of each prism within a 35 degree half-angle from the normal to the face undergoes three reflections and is subsequently reflected back parallel to the direction from which it arrived. Divergence in the reflected ray due to diffraction and inaccuracies in alignment of prism faces is specified such that 80 percent of the reflected ray will fall within a cone of 10^{-4} radians in diameter.

Each prism is epoxy-bonded to an aluminum bracket which in turn is epoxy-bonded to the honeycomb structure panel in a mosaic arrangement. The total number of prisms is 360. The total weight of the laser reflector assembly is 10 lbs.

The ground based optical transmitter will be a pulsed 1 micro-second ruby laser. The transmitted beam will have an angular diameter of 10^{-3} radians and will contain one joule per pulse. The wavelength of the light will be 6943 angstroms. For each joule of optical energy transmitted the satellite borne laser reflector will intercept and reflect approximately 3×10^{10} photons.

Ephemeral predictions based upon the Space Tracking and Data Acquisition Network tracking data will be used to program the orientation of the ground equipment for acquisition.

4.4.3 Experimenters and Their Experiments.

The S-66 Polar Ionosphere Beacon Satellite will transmit seven frequencies which will allow experimenters all over the earth to pursue ionospheric studies by ground based observation of the satellite signals. The principal experimenters, their observing station locations, and the observations which will be made by each are listed in Table 4-2.

In addition to the principal experimenters it is expected that some 50 to 100 investigators will be participating in the S-66 program (Table 4-3).

TABLE 4-2

PRINCIPAL EXPERIMENTERS	STATION LOCATION	TYPE OF OBSERVATION
Dr. W. J. Ross	State College, Pennsylvania	F, D
	Huancayo, Peru	F, D
Dr. G. W. Swenson	Adak, Alaska	F, D, S
	Baker Lake, Canada	F, D, S
	Houghton, Michigan	F, D, S
	Urbana, Illinois	F, D, S
Dr. O. K. Garriott	Palo Alto, California	F, D
	Honolulu, Hawaii	F, D
Mr. R. Lawrence	Boulder, Colorado	F, D
	College, Alaska	F, D
Mr. L. Brace	Space Tracking and Data Acquisition Network	E
Mr. L. Blumle	Blossom Point, Maryland	F, D, S
	Johannesburg, S. Africa	F, S
Dr. H. H. Plotkin	Wallops Island, Virginia	L

LEGEND:
- F - Faraday Rotation
- D - Doppler
- S - Scintillation
- E - Electron Density
- L - Laser

TABLE 4-3

INVESTIGATOR	STATION	LOCATION
ARGENTINA		
Radicella, S. M.	Tucuman	Argentina
AUSTRALIA		
Armstrong, E. B.	Camden	Australia
Briggs, G. H.	Adelaide	South Australia
Gerrard, C. N.	Woomera	Australia
Munro, G. R.	Sydney	Australia
Webster, H. C.	Brisbane	Australia
AUSTRIA		
Bunkard, O.	Graz	Austria
BRAZIL		
de Mendonca, F.	Belem	Brazil
	Natal	Brazil
	San Jose dos Campos	Brazil
	Conception	Chile
	Ushuaia	Argentina
CANADA		
Davadas, A.	Saskatoon, Saskatchewan	Canada
FRANCE		
Papet-Lepine, J.	Vellepreux	France
Vassy, E.	Paris	France
GERMANY		
Dieminger, W.	Lindau	Germany
Kaminski, H.	Bodhum	Germany
Rawer, K.	Breisach	Germany

INVESTIGATOR	STATION	LOCATION
GREECE		
Anastassiades, M.	Athens	Greece
INDIA		
Mitra, A. P.	New Delhi	India
Ramanathan, K. R.	Ahmedabad	India
Rao, E. B.	Hyderabad	S. India
ITALY		
Checcacci, P. F.	Florence	Italy
JAPAN		
Nakata, Y.	Tokyo	Japan
KENYA		
Hunter, A. N.	Nairobi	Kenya
Koster, J. R.	Nairobi	Kenya
NEW ZEALAND		
Mawdsley, J.	Campbell	New Zealand
Titheridge, J. E.	Invercargill	New Zealand
	Auckland	New Zealand
	Wellington	New Zealand
SPAIN		
Romana, A.	Tortosa	Spain
SWEDEN		
Liszka, L.	Kiruna	Sweden
SWITZERLAND		
Golay, M.	Colovrex	Switzerland

INVESTIGATOR	STATION	LOCATION
UNITED KINGDOM		
Beynon, W. J.	Aberystwyth	England
Burgess, B.	South Farnborough	England
Taylor, G. N.	Jodrill Bank	England
Weekes, K.	Sidmouth, Devon	England
Wilkins, A. F.	Slough	England
	Singapore	Malaya
	Hong Kong	China
	Bangkok	Thailand
UNITED STATES		
Aarons, J.	Hamilton	Massachusetts
Arendt, P. R.	Deal	New Jersey
Beamer, C. M.	Cedar Rapids	Iowa
Berning, W. W.	Aberdeen	Maryland
Blumle, L. J.	Blossom Point	Maryland
	Johannesburg	S. Africa
Garriott, O. K.	Palo Alto	California
	Honolulu	Hawaii
German, J. P.	College Station	Texas
Houston, R. E.	Durham	New Hampshire
Lawrence, J. D.	Williamsburg	Virginia
	Ft. Meade	Maryland
Lawrence, R. S.	Boulder	Colorado
Mechtly, E. A.	Huntsville	Alabama
Ross, W. J.	University Park	Pennsylvania
	Huancayo	Peru
Sales, G. S.	Weston	Massachusetts
	Hanover	New Hampshire
	Thule	Greenland
Swenson, G. W.	Adak	Alaska
	Baker Lake	Canada
	Houghton	Michigan
	Urbana	Illinois

4.5 TRACKING SYSTEM.

4.5.1 Active Tracking.

The GSFC Space Tracking and Data Acquisition Network (STADAN) will be responsible for tracking the S-66 satellite throughout the useful life of the tracking/telemetry (136.170 Mc) transmitter - nominally three years. The tracking operations will consist of two phases: the launch and early orbit phase and the normal tracking phase.

4.5.1.1 Launch and Early Orbit Phase.

During the launch and early orbit phase, all STADAN stations having interferometer tracking capability will be required to track the spacecraft. In addition other organizations will be requested to track the spacecraft and furnish tracking data to GSFC. Tracking will be required from the below listed stations on the basis of capability.

4.5.1.1.1 Antofagasta, Chile
Blossom Point, Maryland
College, Alaska
East Grand Forks, Minnesota
Fort Myers, Florida
Goldstone, California
Johannesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

4.5.1.1.2 GSFC Data Acquisition Facility - 85' Dish.

Gilmore Creek, Alaska (ULASKA)

4.5.1.1.3 Pacific Missile Range - FPS-16 Radar.

San Nicolas Island

4.5.1.1.4 Pacific Missile Range - Doppler.

Point Arguello, California

4.5.1.1.5 Transit Doppler Ground Stations.

APL/Howard County, Maryland
Austin, Texas
Las Cruces, New Mexico
Lasham, England
Anchorage, Alaska
Misawa, Japan
Pretoria, S. Africa
Smithfield, Australia
South Point, Hawaii
San Jose Dos Compos, Brazil
San Miguel, Phillippines

4.5.1.1.6 Smithsonian Astrophysical Observatory

All appropriate Baker-Nunn Stations and Moonwatch Teams.

4.5.1.1.7 NORAD Space Detection and Tracking Systems.

U. S. Naval Space Surveillance Stations
Laredo, Texas

4.5.1.1.8 Defence Research Telecommunications Establishment.

Prince Albert, Saskatchewan

4.5.1.2 Normal Phase.

The normal tracking phase will begin upon notification from the Space Operations Control Center and will continue for the useful life-time of the satellite. The STADAN stations listed above in Section 4.5.1.1.1 will be responsible for tracking the satellite during this phase.

4.5.2 Passive Tracking.

4.5.2.1 Launch and Early Orbit Phase.

The satellite is to be passively tracked by means of optical and radar sensors until sufficiently accurate set of orbital elements are obtained to satisfy operational requirements.

4.5.2.2 Normal Phase.

Optical tracking may be required to track the S-66 spacecraft after the spacecraft ceases to transmit.

4.6 DATA ACQUISITION.

4.6.1 General Requirements.

The acquisition and recording of telemetered data from the S-66 Polar Ionsophere Beacon Satellite shall be the responsibility of the GSFC Space Tracking and Data Acquisition Network, although data will also be recorded by the Johns Hopkins University, Applied Physics Laboratory during those periods when the spacecraft is transmitting telemetry data which is acquirable by use of their ground facilities.

The telemetering will be done on the 136.170 Mc., phase modulated, 350 milliwatt signal. The transmitter will be modulated by the combined outputs of two subcarriers. The carrier will be on continuously from launch, and will remain on except for certain critical periods when it may be necessary to command the spacecraft to a specific mode of operations.

4.6.2 Station Participation.

4.6.2.1 Goddard Space Flight Center.

Antofagasta, Chile
Blossom Point, Maryland
College, Alaska
East Grand Forks, Minnesota
Fort Myers, Florida
Goldstone, California
Johnnesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

4.6.2.2 Johns Hopkins University, Applied Physics Laboratory Howard County, Maryland.

4.6.3 Recording Requirements.

4.6.3.1 Telemetry.

The recording of telemetered data from the S-66 satellite for the GSFC Space Tracking and Data Acquisition Network stations listed above in Section 4.6.2.1 will be in accordance with schedules received from the GSFC Network Controller and based upon the below listed requirements.

4.6.3.1.1 Two passes per day; one pass being after a period of maximum darkness for the spacecraft and the other being after a period of maximum sunlight.

NOTE: A different STADAN station should obtain the data each day.

4.6.3.1.2 Four passes per day (maximum of two passes per day from any one STADAN station); those passes in which the S-66 satellite is mutually visible between the Experimenters stations, with a minimum zenith angle of 60 degrees and minimum mutual visibility within this angle of three minutes, and the STADAN stations listed in Table 4-5.

4.6.3.1.3 As much data as possible will be recorded from the STADAN stations for six days following the occurrence of certain expected magnetic storms (class two (2) or larger solar flares).

TABLE 4-5

EXPERIMENTERS STATIONS	SPACE TRACKING AND DATA ACQUISITION NETWORK STATIONS
Palo Alto, California	Antofagasta, Chile
Honolulu, Hawaii	Blossom Point, Maryland
Boulder, Colorado	College, Alaska
Huancayo, Peru	E. Grand Forks, Minnesota
University Park, Pennsylvania	Fort Myers, Florida
Adak, Alaska	Lima, Peru
Baker Lake, Canada	Goldstone, California
Houghton, Michigan	Quito, Ecuador
Urbana, Illinois	Santiago, Chile
	St. Johns, Newfoundland
	Winkfield, England

4.6.3.2 Beacon Data.

The recording of beacon data from the S-66 satellite for the Blossom Point, Maryland and Johannesburg, S. Africa STADAN stations will be scheduled by the GSFC Network Controller. Present plans are for recording three to four passes per day (minimum elevation angle of 45 degrees).

NOTE: All special purpose equipment required for the acquisition and recording of beacon data will be supplied by the GSFC experimenter Mr. L. J. Blumle.

4.7 QUICK-LOOK DATA.

In order that the status of the S-66 spacecraft may be evaluated as soon after launch as possible and during the normal phase, special "quick-look" procedures have been established for the analysis of the telemetered data. These procedures are based upon requirements established by the GSFC Project Manager, Applied Physics Laboratory, and the Tracking and Data Systems Directorate as described in Section 6.2.4. Present plans for reducing and analyzing the quick-look status data will be in conjunction with the recording responsibility as outlined in Section 4.6.3.1.1.

4.8 COMMAND.

Since all S-66 frequencies will be transmitted continuously from launch through normal satellite operations, commands may be issued in order to exercise portions of the payload during the early orbit phase or to de-energize portions of the payload in the case of a malfunction.

The GSFC stations listed in Section 4.6.2.1 and the Applied Physics Laboratory station listed in Section 4.6.2.2 will be responsible for interrogating the S-66 spacecraft.

All command requirements will be coordinated with the GSFC Project Manager, Applied Physics Laboratory Liaison Officer, and the GSFC Network Controller.

4.9 TRANSMITTAL PROCEDURES.

4.9.1 Quick-Look Data.

The quick-look data obtained during the launch, early orbit, and normal periods will be forwarded to the GSFC Space Operations Control Center (NETCON), via teletype, as soon as possible after it is obtained.

4.9.2 Recorded Telemetry Data.

During the Launch and Early Orbit Phase, all recorded telemetry and associated data will be forwarded in accordance with the standard tape mailing instructions to:

Analog Tape Library, Code 565
Goddard Space Flight Center
Greenbelt, Maryland, U. S. A.

as soon as possible. All data obtained after this time will be forwarded to the above addressee in accordance with the standard tape mailing instructions and routine procedures.

4.10 DATA PROCESSING.

The processing and reduction of telemetered data from the S-66 spacecraft, with the exception of the electron density information which will be a responsibility of the experimener(s) concerned, will be a responsibility of the Space Data Acquisition Division of the Goddard Space Flight Center.

Limited processing and reduction of S-66 telemetered data in the form of quick-look status information will be a joint responsibility of the Operations and Support Division of the Goddard Space Flight Center and the Johns Hopkins University, Applied Physics Laboratory.

5.0 SPACE OPERATIONS CONTROL CENTER.

5.1 ORGANIZATION.

The Space Operations Control Center (SOCC) organization includes personnel with the following functions:

Operations Director
Project Operations Coordinator
Technical Adviser to NASA Headquarters
Spacecraft Controller
Network Controller
Data Systems Coordinator
Project Representative
Communication Controller
External Agency Coordinator
Public Information Officer

Additional personnel will be appointed as required by the Operations Director and as dictated by the Project requirements.

5.2 OPERATIONS CONTROL.

The Space Operations Control Center shall maintain control over operations of the Space Tracking and Data Acquisition Network and will coordinate requirements and responsibilities with the other participating organizations. The operations will consist of two distinct periods:

Launch and Early Orbit Phase
Normal Phase

5.2.1 Launch and Early Orbit Phase.

5.2.1.1 Countdown Schedule.

This countdown schedule is referenced to the nominal lift-off time (T-0) and lists only those periods in the countdown which require action by personnel in the Space Operations Control Center.

COUNTDOWN	ACTION
T-10 Days	Forward notification of nominal launch date and time to all participating stations, SAO, NORAD, SPACETRACK, SPACE SURVEILLANCE, and SPACEWARN.
	Forward Nominal Doppler frequencies, (162 and 136 Mc) to the GSFC Mission Directors Center (MDC), Pt. Arguello, California.
	Send Nominal GSFC Prediction Bulletin to all experimenters.
T-7 Days	Communications Test.
	NOTE: This test will be initiated by SPACON.
T-5 Days	Send Nominal Predictions to all participating stations.
T-1 Day	Set condition GREEN (See Section 7 for explanation of conditions).
	Alert all stations to be prepared to implement OPPLAN 2-63.
T-120 Min.	Set condition RED.
	Alert all stations that launch is imminent.
	Receive readiness reports from all stations.
T-60 Min.	Receive second readiness report from all stations.
	Establish Operations Liaison and Project Liaison phone circuits between the Space Operations Control Center and the Mission Directors' Center, Pt. Arguello, California.

COUNTDOWN	ACTION
T-60 Min. (Cont'd)	Receive report of vehicle and spacecraft status via Operations Liaison phone circuit. Establish APL Liaison phone circuit between the Space Operations Control Center and the Johns Hopkins University Applied Physics Laboratory.
T-30 Min.	Establish all remaining phone circuits.
T-15 Min. to T-0	Receive spacecraft beacon frequencies from MDC Operations Liaison Officer, via phone, and forward to all stations. Receive all pertinent pre-launch information by phone and/or TTY and relay to all stations concerned.
LIFT-OFF	Receive lift-off by phone from MDC Operations Liaison Officer and forward to GSFC Space Communications Center for immediate relay to all stations. NOTE: All phone circuits between SOCC and MDC will be established by MDC.

5.2.1.2 Telephone Communications.

Telephone communications for liaison, coordination, and/or data collection will be established as outlined below.

5.2.1.2.1 Space Operations Control Center (SOCC) to GSFC Mission Directors' Center (MDC), Pt. Arguello, California - Operations Liaison Officer.

SOCC Number "C" to MDC Number "A"

This circuit will be the initial contact with the MDC and will be used to keep SOCC fully informed of the status of the launch operations. The information to be received over this phone will include vehicle and payload status, countdown, accurate lift-off time, vehicle staging, and other information pertinent to the operations.

5.2.1.2.2 Space Operations Control Center (SOCC) to GSFC Mission Directors' Center (MDC), Pt. Argeullo, California - Doppler Liaison Officer.

SOCC Number "A" to MDC Number "B"

This phone will be used to receive Doppler data on a real time basis, and will serve as a backup to the initial phone contact with the MDC.

5.2.1.2.3 Space Operations Control Center (SOCC) to GSFC Mission Directors' Center (MDC) - Senior GSFC Project Representative.

SOCC Number "B" to MDC Number "C"

This phone circuit will be used for communications between the S-66 Project Representative at GSFC and the senior S-66 Project Representative at the MDC.

5.2.1.2.4 Space Operations Control Center (SOCC) to Prince Albert Radar Laboratory (PARL), Prince Albert, Saskatchewan - PARL Liaison Officer.

SOCC Number "K" to PARL Number "A"

This phone circuit will be used to keep the PARL personnel fully informed of the progress and status of the launch and early orbit operations.

5.2.1.2.5 Space Operations Control Center (SOCC) to NASA Headquarters Mission Status Room - Technical Liaison Officer.

SOCC Number "G" to NASA Headquarters Number "A"

This phone circuit will be used to keep the NASA Headquarters Mission Status Room fully informed of the progress and status of the launch and early orbit operations at all times. This information will be received in the Mission Status Room by the Tracking and Data Acquisition Liaison Officer, Mr. R. D. Heckel.

5.2.1.2.6 Space Operations Control Center (SOCC) to NASA Headquarters Press Room - Public Information Officer.

SOCC Number "H" to NASA Headquarters Number "B"

The NASA Headquarters Press Room will be kept fully informed of the status and progress of the launch and early orbit operations at all times via this phone.

5.2.1.2.7 Space Operations Control Center (SOCC) to Applied Physics Laboratory (APL), Howard County, Maryland - APL Liaison Officer.

SOCC Number "J" to APL Number "A"

This phone circuit will be used for communications between the SOCC and the S-66 Project Representative at APL.

5.2.1.2.8 Space Operations Control Center (SOCC) to Point Mugu Computing Center - Computer Liaison Officer.

SOCC Number "N" to Point Mugu Number "A"

This circuit will be activated to receive radar data and orbital parameters, and will serve as a backup to the initial TTY circuit with Point Mugu.

5.2.1.3 Launch Data.

Launch information in the form of Doppler, vehicle, trajectory and orbit information, and station acquisition and loss information will be given to the appropriate personnel in the Space Operations Control Center for entry on the display facilities.

5.2.1.4 Interferometer Data.

Interferometer Data will be received by COMPUT and undergo prescribed logging and filing. During the launch and early orbit phase, a copy of all data messages will be received by the Early Orbit Determination Group for checking the data quality and ambiguity resolution . The teletype tape will be processed by the Minitrack Section using the CDC 160 edit program. The data on BCD observation cards will be forwarded to the Early Orbit Determination Group for orbital computation.

A copy of the interferometer data observations converted to time, azimuth and elevation (near or at meridian or latitude crossing) will be sent to SAOCAM, SPATRK, SPASUR, and SPADATS as soon as available for use in orbital computations.

5.2.1.5 Radar, Doppler, Optical, Miscellaneous Data.

All tracking data received by the Space Communications Center which have not already been described, such as radar, doppler, optical, etc., shall be sent to the Early Orbit Dètermination Group for orbital computations.

5.2.1.6 Space Operations Control Center Displays.

Appropriate displays shall be maintained in the SOCC during the launch and early orbit phase to keep the GSFC Operations personnel informed of the status of the operation.

5.2.1.6.1 World Map Board.

The World Map Board indicates the status of each station by means of individual lights as follows:

COLOR	STATUS
STATIC GREEN	READY
STATIC RED	NOT READY
FLASHING GREEN	SPACECRAFT SIGNAL ACQUIRED
FLASHING AMBER	ACQUISITION SCHEDULED BUT NOT REPORTED
STATIC AMBER	PASS ENDED

5.2.1.6.2 General Status Screen.

Prior to lift-off, this screen will show countdown status such as times and lengths of hold as well as the terminal Scout Vehicle countdown.

During launch, vehicle performance will be shown by indicating confirmation of each item in the launch sequence as it is received; i.e. ignition and burnout of each stage, etc. Pertinent teletype messages will also be projected for general viewing.

After injection of the spacecraft into orbit, this screen will show station names, predicted and actual signal acquisition and loss times, predicted and actual times of station axes crossings, predicted zenith angle, and maximum AGC received. This information will be kept current and as close to real-time as possible.

5.2.1.6.3 Doppler Plot Screen.

Beginning at launch, the Doppler data will be received over the SOCC to PMR phone communications and will serve as an input to the Iconorama projector. The Iconorama will plot the Doppler data and project it on a screen for general viewing in the SOCC. The Doppler plot shows frequency versus time as an indication of vehicle performance.

After the Doppler plot is completed, a world map will be projected on this screen, and the nominal sub-satellite plot will be drawn in "real-time" to indicate the approximate position of the satellite at any given time.

5.2.1.6.4 Launch and Orbital Parameters Board.

This board will show the nominal and actual orbital elements, and other pertinent information relating to the vehicle and spacecraft.

5.2.1.7 Schedules Section.

During the launch and early orbit phase the Network Control Group (NETCON), will be responsible for the following.

5.2.1.7.1 Scheduling and monitoring the Operations of the Space Tracking and Data Acquisition Network.

5.2.1.7.2 Maintaining the SOCC displays in near real-time status.

5.2.1.7.3 Ensuring for the Early Orbit Determination Group that S-66 receives first tracking priority at the Space Tracking and Data Acquisition Network stations.

5.2.1.7.4 Preparing (in conjunction with the Early Orbit Determination Group and the Data Processing Branch) and submitting a Launch Operations Control Report to the Assistant Director for Tracking and Data Systems at 0800 hours E.S.T. during the 3 day period after launch. Copies of this report will be forwarded to those personnel on the S-66 Launch and Early Orbit Distribution List.

5.2.1.7.5 Maintaining cognizance of the spacecraft's status. Graphs, logs, and/or tabulation of various spacecraft parameters, such as main solar charge current, command battery current, load current, battery voltage, temperatures, and charge regulator performance, etc. will be kept. Twice a day quick-look information concerning the above mentioned parameters will be obtained via TTY from certain scheduled quick-look telemetry acquisition stations.

This information will be interpreted, using the calibration data supplied by the Johns Hopkins University, Applied Physics Laboratory, and forwarded via TWX to:

Transit Control Center
Applied Physics Laboratory
Laurel, Maryland
Attn: Duty Officer

as soon as possible after it is interpreted.

5.2.1.7.6 Maintaining liaison with the Johns Hopkins University, Applied Physics Laboratory personnel at Howard County, Maryland. The purpose of this liaison will be to coordinate spacecraft status and command requirements.

5.2.2 Normal Phase.

Upon notification from the Operations Director, the Network Control Group will enter the normal operating phase of the S-66 Project and will so continue for the scientific lifetime of the spacecraft, nominally three years.

During this phase, the Network Control Group will schedule tracking and data acquisition activities in accordance with the requirements of the Project and the Spacecraft Priority Schedule.

The Network Control Group will also be responsible for receiving, interpreting, and forwarding quick-look spacecraft status information as described in Sections 5.2.1.7.5 and 5.2.1.7.6.

6.0 FIELD STATION OPERATIONS.

Field stations belonging to the below listed organizations will participate in the S-66 project.

Goddard Space Flight Center
NORAD Space Detection and Tracking System
Smithsonian Astrophysical Observatory
Transit Navigational Network
Pacific Missile Range
Defense Research Telecommunications Establishment

The responsibilities for the stations as outlined in the following paragraphs are necessarily brief and often general. Consequently at times the judgement of station personnel must be exercised in order that the requirements of the project are most satisfactorily met. Also, it is to the benefit of all concerned for the station to feel free to make an inquiry whenever there is a question on the operations.

6.1 COUNTDOWN.

This countdown is referenced to the launch time (T-0) and shown only those items which are of interest to the participating field stations.

COUNTDOWN	ACTION
T-10 Days	Receive notification of nominal launch date and time.
T-7 Days	Communications Test.
	NOTE: This test will be initiated by SPACON.
T-5 Days	Receive nominal predictions.
T-42 Hours	PMR submit launch status report to NETCON.

COUNTDOWN	ACTION
T-24 Hours	Receive message from NETCON which states that network condition is GREEN.
	Receive message from NETCON which states that station should be prepared to implement Operations Plan 2-63.
T-23 Hours	PMR submit launch status report to NETCON.
T-18 Hours	PMR submit launch status report to NETCON.
T-180 Min.	PMR again submit launch status report to NETCON.
T-150 Min.	Receive network grouping from SPACON. Send four lines of FOX test to SPACON upon request.
T-120 Min.	Receive notice from NETCON that network condition is RED and that MINIMIZE is imposed.
	Receive message from NETCON which states that launch is imminent.
	Submit station readiness report to NETCON.
T-60 Min.	Again submit station readiness report to NETCON.
	NOTE: All stations are assumed to be operational after this time unless NETCON is notified otherwise.
	Receive PMR launch information via SPACON.

COUNTDOWN	ACTION
T-15 to T-0	Receive all pertinent pre-launch information.
LIFT-OFF	Receive lift-off time from NETCON via phone and/or TTY.

6.2 GSFC TRACKING AND DATA ACQUISITION STATIONS.

6.2.1 Tracking.

6.2.1.1 Interferometer Tracking.

The Space Tracking and Data Acquisition Network (STADAN) stations responsible for interferometer tracking S-66 for the active lifetime of the satellite, nominally three years, are as follows:

Antofagasta, Chile
Blossom Point, Maryland
College, Alaska
E. Grand Forks, Minnesota
Fort Myers, Florida
Goldstone, California
Johannesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

6.2.1.1.1 Launch and Early Orbit Phase.

During the launch and early orbit phase, the above STADAN stations will track the 136.170 Mc satellite beacon frequency on all predicted tracking passes and submit automatic digital data to COMPUT in accordance with established standard operating procedures. Analog data will also be taken but will not be sent unless requested. In addition, the pass reports (giving signal acquisition time, AGC levels, etc.) will be sent to NETCON in accordance with established standard operating procedures.

6.2.1.1.2 Normal Phase.

The normal tracking phase for the S-66 project will begin upon notification from the Space Operations Control Center, and will continue for the useful lifetime of the satellite. The STADAN stations listed in Section 6.2.1.1 above will be responsible for tracking the spacecraft during this phase. Tracking data will be sent to COMPUT in accordance with established standard operating procedures.

6.2.1.2 Gilmore Creek, Alaska (ULASKA).

The ULASKA station will be responsible for tracking the S-66 spacecraft beacon frequency (136.170 Mc.) during the first pass and submitting angular tracking data to GSFC for orbital computations.

6.2.2 Commands.

The Consolidated Systems Corporation command encoder will be used to generate command tones "A, B, and C" to the S-66 spacecraft. The specific tone bursts will amplitude modulate the 148.260 Mc. carrier frequency.

The commands that will be used for commanding the S-66 spacecraft are listed in Table 6-1. All commands will be for a period of 0.5 seconds each and a separation of 0.5 seconds will be used between tones.

TABLE 6-1

COMMAND	FUNCTION
"C"	Energizes the spacecraft command logic.
"A"	Steps channel "A" selector switch one step forward (clockwise) for each command pulse.
"B"	Steps channel "B" selector switch one step forward (clockwise) for each command pulse.

6.2.2.1 Station Responsibility.

The STADAN stations responsible for executing commands "A, B, and C" are as follows:

Antofagasta, Chile
Blossom Point, Maryland
College, Alaska
E. Grand Forks, Minnesota
Fort Myers, Florida

Goldstone, California
Johannesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

6.2.2.1.1 All station interrogation responsibilities will be scheduled by the Network Control Group in accordance with instructions of the Project Manager or his representative and the Spacecraft Priority Schedule.

6.2.2.1.2 A command that is not accepted by the satellite should be repeated at approximately 15 sec. intervals until it is given 5 times. If a command that is scheduled for a particular station on a particular pass is given more than once or not at all, a PRIORITY message is to be sent to NETCON. This message should be sent within 10 minutes of the abnormal command operations and should specify the total number of times that the command was given. It should also include an opinion whether the fault is within the satellite or is within the ground station operations or equipment.

6.2.2.2 Command Instruction.

Table 6-3 presents the format to be used in preparing the Consolidated Systems Corporation command encoder for generation of command tones "A, B, and C".

TABLE 6-2

SWITCH NUMBER	SWITCH NOMENCLATURE	FUNCTION	SWITCH POSITION COMMAND A	B	C
1	MODE	MANUAL TONE MODE	T	T	T
2	CODE	NOT APPLICABLE	-	-	-
3	SEQ	TONE FORMAT (T1)	4	4	4
4	ADDRESS	NOT APPLICABLE	-	-	-
5	1st	TONE FREQUENCY	09-12	10-05	09-06
6	2nd	NOT APPLICABLE	-	-	-
7	3rd	NOT APPLICABLE	-	-	-
8	4th	NOT APPLICABLE	-	-	-
9	TIME	TONE DURATION	0.5 sec.	0.5 sec.	0.5 sec.
10	TX	"0" FOR CHECK: then select appropriate transmitter.			

6.2.3 Data Acquisitions.

6.2.3.1 Station Responsibilities.

The below listed STADAN stations shall have responsibility for recording telemetered data from the S-66 satellite using the 136.170 Mc beacon frequency. These stations are:

Antofagasta, Chile
Blossom Point, Maryland
College, Alaska
E. Grand Forks, Minnesota
Fort Myers, Florida
Goldstone, California
Johannesburg, S. Africa
Lima, Peru
Quito, Ecuador
Santiago, Chile
St. Johns, Newfoundland
Winkfield, England
Woomera, Australia

All data acquisition periods will be scheduled by the Network Control Group and data will be recorded only during these periods.

6.2.3.2 General Receiving Instructions.

A block diagram showing the data acquisition system is shown in Figure 9.

6.2.3.2.1 Antenna Polarization-Circular.

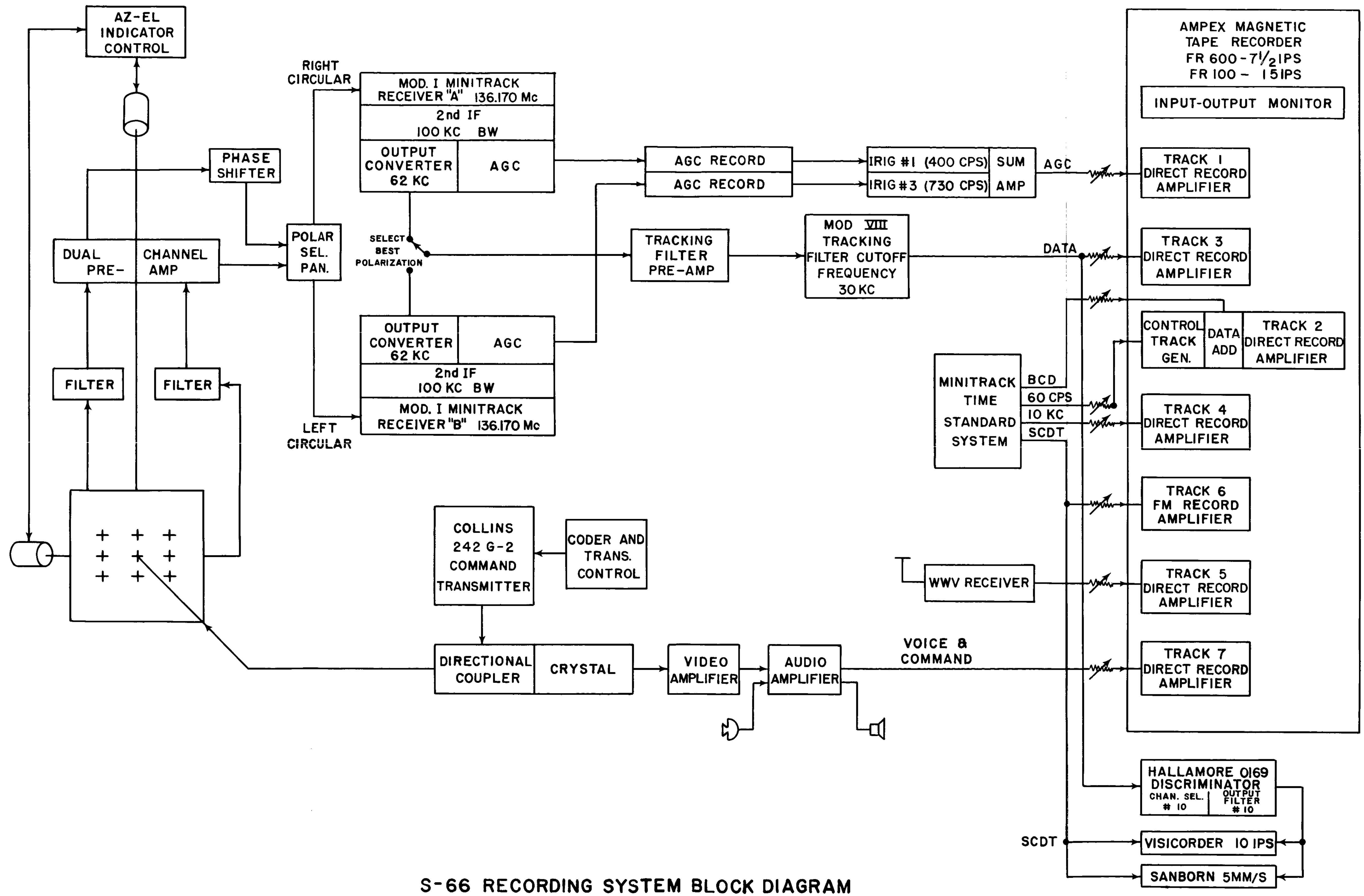
6.2.3.2.2 Dual Channel Pre-Amplifier-136.500 Mc.

6.2.3.2.3 Mod I Telemetry Receiver.

Inputs

Receiver "A" - PM output of right circular polarized antenna system. (Frequency 136.170 Mc.)

Receiver "B" - PM output of left circular polarized antenna system. (Frequency 136.170 Mc.)



S-66 RECORDING SYSTEM BLOCK DIAGRAM

FIGURE 9

Bandwidth

2nd I.F. - 100 Kc.

Outputs

Output Converted - 62 Kc. center frequency.
2nd I.F. - AGC

6.2.3.2.4 Tracking Filter.

Input

62 Kc. output of Mod I receiver having highest signal level.

Output

Phase Modulation Output - detected signal.
PM cutoff filter - 30 Kc.

6.2.3.2.5 Minitrack Timing Signals.

Time-Serial and Binary Coded
Precision Clock Drive - 60 cps
Standard Frequency - 10 Kc.

6.2.3.2.6 Magnetic Tape Recorder Speed.

FR-600-7 1/2 inches per second.
FR-100-15 inches per second.

6.2.3.2.7 Magnetic Tape Recorder Track Assignments.

TRACK	RECORD AMPLIFIER	SOURCE	SIGNAL
1	Direct	AGC Record Control	Multiplexed AGC
2	Direct	Control Track Generator and Minitrack Time Standard	60 cps AM on 18.24 Kc. carrier BCD Time
3	Direct	PM Output of Tracking Filter	Detected Signal
4	Direct	Minitrack Time Standard	10 Kc. Standard

TRACK	RECORD AMPLIFIER	SOURCE	SIGNAL
5	Direct	WWV Receiver	WWV Time
6	FM	Minitrack Time Standard	Serial Coded Time
7	Direct	Audio Amplifier	Voice and Command Tones

6.2.4 Quick-Look Data.

6.2.4.1 General.

The STADAN stations listed in Section 6.2.3.1, which have been assigned telemetry acquisition and recording responsibilities, will also be responsible for submitting a TTY report to NETCON concerning the status of certain critical housekeeping functions (Table 6-3) as soon as possible after loss of signal. All quick-look periods will be scheduled by the Network Control Group and quick-look data will be supplied only during these periods.

TABLE 6-3

CHANNEL (PAM)	PARAMETER
24	Main Solar Charge Current
23	Command Battery Current
25	Load Current
27	-10.7 Volt Battery Voltage
26	-24.3 Volt Battery Voltage
1 (SEE NOTE BELOW)	Seven Temperatures
9 (SEE NOTE BELOW)	Charge Regulator Performance

NOTE: A PDM encoder, synchronized with channel 1 of the 35 channel PAM commutator, will make seven different temperature measurements each frame of the 35 channel commutator. All seven temperature measurements will be required for the housekeeping data.

A telltale register, synchronized with channel 9 of the 35 channel PAM commutator, will sub-commutate seven pieces of information of the ON/OFF variety and has a PCM output format. Only telltale number 2 (charge regulated performance) will be required for housekeeping data.

6.2.4.2 Quick-Look Recording Instructions.

Due to the channels required for monitoring the status of the S-66 spacecraft, station personnel will be required to discriminate and display on the Sanborn and Visicorder recorders three separate readouts; one for the PAM data, one for the PDM data, and one for the PCM data. A block diagram showing the quick-look recording system is shown in Figure 9.

6.2.4.2.1 PAM Data.

6.2.4.2.1.1 General.

One frame of the commutator consists of 35 channels. Each channel duration is 0.629 seconds; however, data is transmitted for only 75% of this time, or 0.472 seconds. Figure 6 illustrates the type of voltage output which can be expected from the two sub-carriers.

Note that in Figure 6 the dead time amplitude does not correspond to 0 volt calibrate but some other level. This is because for this 25% of the sample time the sub-carrier is open circuit, and the open circuit frequency is not the same as the short circuit frequency. It should also be noted that on both outputs, the amplitudes which exceed approximately 30% of full scale are shown as noisy channels. Signal drop-outs will occur when the input level exceeds full scale value by about 30 or 40%. This is because no limiter exists in front of the sub-carrier oscillator, and as the frequency is increased due to the low pass filter on its output.

6.2.4.2.1.2 Determining Frame Sequence.

In reducing PAM data, it is required that the individual channel can be identified. The techniques that should be used in S-66 are as follows:

6.2.4.2.1.2.1 Locate the PDM burst. The PDM encoder reads out on Channel 1 and contains considerable high frequency data.

6.2.4.2.1.2.2 Locate the telltale register. The telltale register on Channel 9 also contains considerable high frequency information, except pulse widths are equal and pulse height is either half scale or full scale.

6.2.4.2.1.2.3 Use both PDM and telltale register. Since both the PDM and the telltale register consist of subcommutated data they therefore have relatively high frequency data, and to insure proper frame synchronization, it is best to determine both the PDM and telltale register. This technique eliminates the possibility of confusing one with the other. Once personnel are familiar with the format it will be obvious which register is which and it will be unnecessary to confirm by finding Channels 1 and 9.

6.2.4.2.1.3 PAM Quick-Look Reduction.

6.2.4.2.1.3.1 Obtain a Sanborn record of the PAM data (Figure 10a). A speed of 5 mm/second should be used.

6.2.4.2.1.3.2 Once frame synchronization has been determined, locate the high and low band edge calibrate channels and draw a straight line between adjacent calibrate points. Then using a scale which is divided with at least 100 divisions per inch, measure the distance between low and high band edge calibrate channels. Then measure the amplitude of channels 23, 24, 25, 26, and 27 with respect to the low band edge calibrate line.

6.2.4.2.1.3.3 Determine the ratio of the amplitude of unknown channels to the amplitude of the full scale calibrate.

6.2.4.2.1.3.4 Record the values of the ratios of channels 23, 24, 25, 26, and 27, in part two of the TTY format as shown in Figure 12.

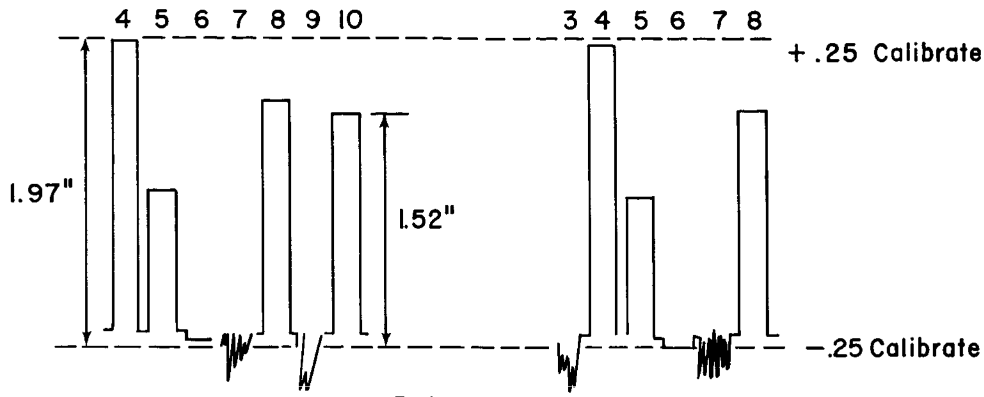
6.2.4.2.1.3.5 Figure 10a shows how a typical channel value is determined by the above technique. In Figure 10a, the height of channel 4 is measured to be 1.97 inches. To determine the value of the active temperature control voltage, channel 10, the high and low band edge lines are constructed and then the amplitude of channel 10 is measured. The ratio of the amplitude of channel 10 to the amplitude of the full scale calibrate, channel 4, is then found by: 1.52/1.97=0.771

6.2.4.2.2 PDM Data.

(Temperature Telemetry on channel 1 of the PAM commutator).

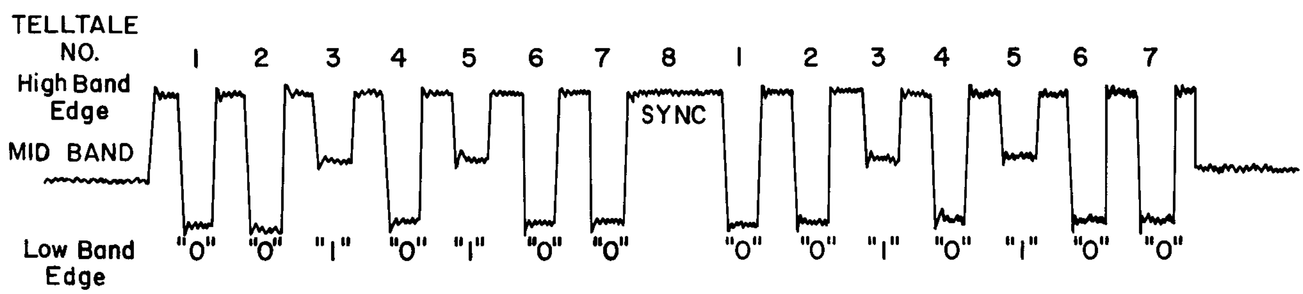
6.2.4.2.2.1 General.

The pattern of the PDM consists of eight positive pulses. The duration of these pulses and the duration of the



5.4 Kc Data
Typical "PAM" Data Reduction Technique

FIGURE 10a



Typical PCM Pulse Train as it would appear on a Visicorder Strip Chart

FIGURE 10b

intervals between these pulses vary from 5 to 35 msec. It is from these variations in duration that the temperature data is obtained.

Figure 11 shows a typical PDM pulse train as it would be displayed on a visicorder recorder. There are eight channels represented by these 15 time intervals (i.e., eight pulses plus seven intervals between pulses). The order of the data channels is as shown in Figure 11. It will be noted that the last seven intervals are repetitious of the first seven and that there is only one interval representing data channel 1.

Data channel 2 is reserved for calibration and the durations of the other seven channels vary in inverse proportion to the temperature at the points being monitored in the satellite.

6.2.4.2.2.2 PDM Quick-Look Reduction.

6.2.4.2.2.2.1 Obtain a visicorder record of the data (Figure 11). A speed of 10 inches per second should be used.

6.2.4.2.2.2.2 Draw a horizontal center line as shown in Figure 11.

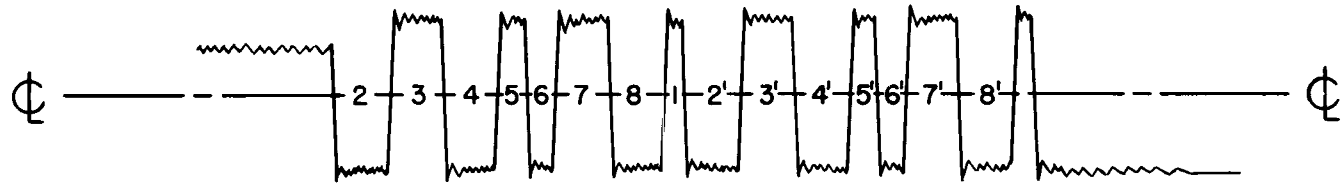
6.2.4.2.2.2.3 Along this center line measure the fifteen intervals. Resolution is improved with ability to measure and a scale of 1/100th of an inch is recommended. However, since ratios of lengths are used, choice of scale is completely arbitrary.

6.2.4.2.2.2.4 Since the last seven intervals are repeats of the first seven, these lengths may be averaged to give seven channel lengths (channels 2 through 8). Channel 1 occurs only once (Figure 11). Proceeding as indicated in Figure 11 should give eight channel lengths of raw data.

6.2.4.2.2.2.5 Record the 8 channel lengths as explained above in part 3 of the TTY format as shown in Figure 12.

6.2.4.2.3 PCM Data.

(Telltale Register on Channel 9 of the PAM Commutator).



Typical PDM Pulse Train as it would appear on
a Visicorder Strip Chart

	Dual Oven Temperature	Calibration	PDM Temperature	Internal Structure Temperature	Battery Temperature	Blade No.1 Temperature	Outer Shell No. 1 Temperature and Payload Separation	Outer Shell No. 2 Temperture
CHANNEL	1	2	3	4	5	6	7	8
RAW DATA	$A_{1'}$	A_2	A_3	A_4	A_5	A_6	A_7	A_8

Raw data is obtained from PDM Strip Chart as follows:

A_1 = Length of 1

$$A_2 = \frac{\text{Length } 2 + \text{Length } 2'}{2}$$

$$A_3 = \frac{\text{Length } 3 + \text{Length } 3'}{2}$$

$$A_4 = \frac{4 + 4'}{2}$$

$$A_5 = \frac{5 + 5'}{2}$$

$$A_6 = \frac{6 + 6'}{2}$$

$$A_7 = \frac{7 + 7'}{2}$$

$$A_8 = \frac{8 + 8'}{2}$$

FIGURE 11

6.2.4.2.3.1 General.

The telltale register transmits seven bits of information on channel 9 of the PAM commutator via a PCM code.

Figure 10b shows a typical PCM sample as it would be displayed on a visicorder recorder.

A "0" state is defined as a pulse of full scale height while a "1" is a pulse of only half full scale. The pulse width is approximately 25 milliseconds long and the time between pulses is equal to the pulse width. Pulse width will vary with temperature and voltage but the time will always be such that the time of eight pulses will be contained in the one channel. The eight channel has been omitted for synchronization purposes.

6.2.4.2.3.2 PCM Quick-Look Reduction.

6.2.4.2.3.2.1 Obtain a visicorder record of the data (Figure 10b). A speed of 10 inches per second should be used.

6.2.4.2.3.2.2 Determine the state ("0" or "1") of telltale number 2 (Figure 10b).

6.2.4.2.3.2.3 Record the state of telltale number 2 under channel 9 in part two of the TTY format as shown in Figure 12.

6.2.4.3 Quick-Look TTY Reporting Format.

The TTY format which will be used in reporting the data will consist of one line of the regular telemetry report, a second part which is made up of data readings from PAM channels 9, 23, 25, 26, and 27, and a third part which is made up of 8 PDM readings (PAM Channel 1). A sample TTY message format is shown in Figure 12.

MM NETCON
DE JOBURG 01
00 022110Z
BT

__________________________(INSERT SPACECRAFT DESIGNATION)

PASS NO	PRED TIME	START TIME	STOP TIME	TAPE NO	SINPO	FREQ	MINS DATA	EQUIP PARA	OPER PARA	SENT TO
0001	232140	232110	233200	2XXQ034	24432	136.170	11	235	2	GSFC

CHANNEL (PAM)

9	23	25	26	27
0	0.442	0.672	0.557	0.682

CHANNEL (PDM)

1	2	3	4	5	6	7	8
0.100	0.300	0.280	0.280	0.160	0.140	0.290	0.290

QUICK-LOOK TTY FORMAT

Figure 12

6.2.5 Ionospheric Stations.

6.2.5.1 Blossom Point, Maryland.

In addition to tracking the 136.170 Mc beacon frequency and recording the 136.170 Mc telemetered data, the Blossom Point STADAN station will also be responsible for receiving and recording the 20, 40, and 41 Mc radiated frequencies.

An explanation of the equipment to be supplied to the Blossom Point station for the 20, 40, and 41 Mc ionospheric data and recording instructions will be provided at a later date.

6.2.5.2 Johannesburg, S. Africa.

The Johannesburg STADAN station, in addition to tracking the 136.170 Mc beacon frequency and recording the 136.170 Mc telemetered data, will be responsible for receiving and recording the 40 and 41 Mc radiated frequencies. An explanation of the equipment to be supplied along with recording instructions to the Johannesburg station will be provided at a later date.

6.2.6 Recorded Telemetry Data.

During the Launch and Early Orbit Phase, all recorded telemetry and associated data will be forwarded in accordance with the standard tape mailing instructions to:

Analog Tape Library, Code 565
Goddard Space Flight Center
Greenbelt, Maryland, U.S.A.

as soon as possible.

All data obtained after this time will be forwarded to the above addressee in accordance with the standard tape mailing instructions and routine procedures.

6.2.7 Telemetry Reports.

Cumulative telemetry reports shall be prepared and submitted in accordance with established standard operating procedures.

6.3 NORAD SPACE DETECTION AND TRACKING SYSTEMS.

The U. S. Naval Space Surveillance System of the NORAD Space Detection and Tracking Systems, is requested to track the S-66 satellite for the first 24 hours after launch and forward the tracking data, via teletype, to the Goddard Space Flight Center "COMPUT" as soon as possible.

6.4 SMITHSONIAN ASTROPHYSICAL OBSERVATORY.

The Smithsonian Astrophysical Observatory is requested to optically track the S-66 satellite during the launch and Early Orbit Phase; i.e. until the orbit is accurately determined by the GSFC Early Orbit Determination Group. The optical tracking data will be sent to the Goddard Space Flight Center via teletype as soon as possible after being acquired. SAOCAM will be notified by NETCON upon termination of the Launch and Early Orbit Phase.

Should the spacecraft 136.170 Mc beacon cease transmitting prior to the termination of the active scientific lifetime of the spacecraft, it is contemplated that SAO will be requested to provide GSFC with orbital and tracking information necessary for computing prediction information for the experimenter stations.

6.5 TRANSIT NAVIGATIONAL NETWORK.

6.5.1 Tracking.

Transmitters in the spacecraft operating at 162 Mc and 324 Mc will enable the Transit Navigational Network to Doppler track the S-66 spacecraft and to participate in the ionospheric experiments.

Tentatively, the following experimental Transit tracking stations will be able to track the S-66 satellite:

APL/Howard County, Maryland
Austin, Texas
Las Cruces, New Mexico
Lasham, England
Anchorage, Alaska
Misawa, Japan
Pretoria, S. Africa
Smithfield, Australia
South Point, Hawaii
Sao Jose Dos Compos, Brazil
San Miguel, Phillippines

Should the spacecraft 136 Mc beacon cease transmitting prior to the termination of the active scientific lifetime of the spacecraft, the Transit Navigational Network will be requested to provide GSFC with orbital and tracking information necessary for computing prediction information for the experimenter stations.

6.5.2 Command, Data Acquisition and Quick-Look Data.

Limited data acquisition, from launch until the termination of the active life of the tracking/telemetry transmitter, will be accomplished by the Johns Hopkins University Applied Physics Laboratory for the purpose of establishing spacecraft status.

All command requirements, except emergency commands, will be coordinated with the GSFC S-66 Project Manager, APL Liaison Officer, and the GSFC Network Controller. The Johns Hopkins Applied Physics Laboratory has been given authorization to give emergency commands without prior consultation with GSFC if they are of the opinion that the time delay caused by consultation with the GSFC representative above would result in possible damage to the spacecraft.

6.6 PACIFIC MISSILE RANGE.

6.6.1 Pacific Missile Range FPS-16 Radar, San Nicolas Island.

The Pacific Missile Range is requested to track the launch vehicle with the FPS-16 radar located on San Nicolas Island during the launch phase and submit raw radar data, injection parameters, and orbital parameters to GSFC for orbital computations as quickly as possible after being obtained.

The raw radar data received at San Nicolas Island will be transmitted via the micro-wave system to the Point Mugu 7090 computer for conversion to Mercury Raw Radar Format Revised for the S-66 Mission and transmitted to GSFC at the rate of one point every six seconds from lift-off through third stage separation.

6.6.2 Mission Directors' Center, Pt. Arguello, California.

The Mission Directors' Center shall relay to SOCC via telephone and/or TTY, as feasible, all pertinent launch data and information, such as vehicle and payload status, countdown, lift-off time and vehicle staging.

6.6.3 GSFC/FPB Satellite Tracking Station, Point Arguello, California.

The GSFC Field Projects Branch at Point Arguello shall Doppler track the spacecraft from lift-off to loss of signal over the rf horizon. Frequency versus time data shall be relayed to the GSFC Space Operations Control Center in a near real time basis, via telephone.

6.7 DEFENCE RESEARCH TELECOMMUNICATIONS ESTABLISHMENT.

The Prince Albert Radar Laboratory station of the Defence Research Telecommunications Establishment, is requested to track the S-66 satellite for the first pass of this satellite and forward the raw radar tracking data, via telephone and/or teletype, to the Goddard Space Flight Center "COMPUT" as soon as possible after signal loss.

7.0 SPACE COMMUNICATIONS CENTER OPERATIONS.

7.1 LAUNCH AND EARLY ORBIT PHASE.

During the launch and early orbit phase, the GSFC Space Communication Center and all participating stations will be fully activated for communication launch operations as required. Communication procedures will be in accordance with TCFP-1 and as supplemented herein. Communications links will be required to all participating stations as indicated in this Operations Plan.

7.1.1 Teletype Operations.

7.1.1.1 Communication Status.

For the purpose of this Operations Plan, the following status conditions will apply for the participating stations in the network.

7.1.1.1.1 Condition BLUE. Normal routine status. Any launch operations over 24 hours in the future.

7.1.1.1.2 Condition GREEN. Launch operations expected within 24 hours in the future.

7.1.1.1.3 Condition RED. Launch operations in progress. Countdown is proceeding on schedule and is within two hours of lift-off. MINIMIZE (transmit only operational traffic pertaining to the launch, unless otherwise authorized or directed by the control station) will be imposed. If lengthy delays occur, the network may be returned to condition GREEN or BLUE, depending upon the expected length of the delay.

7.1.1.2 Abbreviated Communication Launch Procedures.

7.1.1.2.1 Upon establishment of condition RED, the following abbreviated procedures will be in effect for participating stations, unless otherwise directed or modified by the control station.

7.1.1.2.1.1 Number continuity is discontinued. Transmissions will be unnumbered. No channel numbers or station serial numbers will be used.

7.1.1.2.1.2 Only the control station will maintain continuity. This will be accomplished by unnumbered channel checks to participating stations by SPA Relay for non-grouped stations and communication checks with grouped stations by SPACON or NETCON as appropriate. These channel checks and communication checks will be sent whenever deemed necessary by the control station and in no case will a circuit be allowed to remain idle over 30 minutes without a continuity check.

7.1.1.2.1.3 No message precedence will be used. All launch traffic will be handled on an operational immediate basis.

7.1.1.2.1.4 Procedure message format will be used for all transmissions. No date-time groups will be used.

<u>Example</u>

NETCON
DE BPOINT
TEXT
*00/0000Z

*Note: Will not be used if examples shown herein for a particular type transmission omits the file time, such as in the case of grouped stations where the direct communication/receipt method is in effect.

7.1.1.2.2 SPA Relay will be the control station for all non-grouped stations participating in launches and tests. SPACON and/or NETCON as designated will be the control station for all grouped stations during launches and tests, except as otherwise indicated in this operations plan.

7.1.1.3 Status Initiation.

The Space Operations Control Center (SOCC) will request that the various status conditions be initiated by the control station as the need arises.

7.1.2 Station Grouping.

When directed by the Man-in-charge of Communication Launch Operations, and in preparation for the pre-launch communication checkout for grouped and non-grouped stations, certain tracking stations will be grouped into launch operation network groups by combining them through use of the leg combining repeaters located at Goddard. Typical station groupings are as follows:

GROUP I	GROUP II	GROUP III
NETCON	NETCON	NETCON
COLEGE/GFORKS/ULASKA	JOBURG	ICONO
FTMYRS	SPACON-D	SPACON-A
BPOINT		
SPACON-C		
PTARGO		
MUGUHQ/MOJAVE/MUGURO/JETLAB		

Group III is a Goddard local arrangement for "in-house" use.

7.1.2.1 Pre-launch Communication Checkout for Grouped Stations.

Selected stations will be grouped usually at least 30 minutes prior to the time they are to be turned over to NETCON, in order to allow time for a thorough circuit grouping checkout. Due to the method of grouping, circuits which are normally full duplex become half duplex. This allows only one station to transmit at a time. Strict circuit discipline must be maintained by all stations in the group(s). The control station will designate which station is to transmit in case of conflict, otherwise, station(s) shall respond in order called. The direct communication/receipt method shall be used by grouped stations, except as modified herein. The following procedures will be employed for grouped stations:

7.1.2.1.1 The control station, upon activating the grouping(s) will send the following opening communication test alert:

Example - Group I

COLEGE GFORKS ULASKA FTMYRS BPOINT PTARGO NETCON
DE SPACON
STATIONS CALLED ARE GROUPED FOR OPPLAN 2-63
LAUNCH. STANDBY FOR OPENING COMM TEST.

After transmission of the opening alert, the control station will direct the grouped stations to commence sending four lines of FOX test. The first station in order called will send its test and await the control station's reply, the second and all others follow in order called in the same manner. After the last station has sent its test, the control station will send its test. All stations will answer in order called. Unless otherwise indicated, the receipt for a communications test means that a station's readability is GOOD/FIVER. Examples of opening communication test and receipts are shown below:

Stations called are being instructed to send 4 lines of FOX test.

COLEGE GFORKS ULASKA FTMYRS BPOINT PTARGO NETCON
DE SPACON
COMMENCE SENDING 4 LINES FOX TEST

Station's response in order called:

DE COLEGE
OPENING COMM TEST

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES
END OF TEST

Control station's reply to opening communication test.

DE SPACON R COMM TEST

Control station's reply if the transmission is received corrupt.

DE SPACON TEST GARBLED STANDBY

7.1.2.1.2 Control station's opening communication test after all stations have completed test and control station has replied to all tests and/or taken corrective action in case of receiving garbled transmissions.

COLEGE GFORKS ULASKA FTMYRS BPOINT PTARGO NETCON
DE SPACON
OPENING COMM TEST

Station's response in order called.

DE COLEGE R COMM TEST
DE GFORKS R COMM TEST
DE ULASKA R COMM TEST
DE FTMYRS R COMM TEST
DE BPOINT R COMM TEST
DE PTARGO R COMM TEST
DE NETCON R COMM TEST

Note: If stations called receive FOX TEST garbled or incomplete, their response will so indicate.

7.1.2.1.3 Communication Checks (COMM CK)

Communication checks (COMM CK) will be initiated by the group control station to ensure circuit continuity after completion of the opening communication test as required.

Examples: COMM CK

COLEGE GFORKS ULASKA FTMYRS BPOINT PTARGO NETCON
DE SPACON
COMM CK

Receipt for COMM CK in order called.

DE COLEGE R COMM CK
DE GFORKS R COMM CK
DE ULASKA R COMM CK
DE FTMYRS R COMM CK
DE BPOINT R COMM CK
DE PTARGO R COMM CK
DE NETCON R COMM CK
-ETC-

7.1.2.1.4 Terminating Groupings.

Termination of an entire grouping or of certain station(s) within a group may be made at any time at the discretion of the control station as follows:

Termination of FTMYRS and BPOINT from GROUP I

FTMYRS BPOINT
DE SPACON
GROUPINGS WITH STATIONS CALLED IS BEING TERMINATED.
HOLD TFC UNTIL TOLD GA TFC BY SPA RELAY.
00/0000Z

7.1.2.2 Pre-launch Communication Checkout for Non-grouped Stations.

7.1.2.2.1 The control station for non-grouped stations (SPA Relay) will initiate an unnumbered channel check test to all non-grouped participating stations usually at approximately 30 minutes prior to condition RED. Stations will return the channel check test as received to signify GOOD/FIVER reception. If the channel check test is received garbled at either end, the sending station will be notified and corrective action taken to eliminate the trouble.

OPS unnumbered channel check test by SPA Relay over a single station line. Multiple station channel checks will be addressed as shown in the example for channel checks with non-grouped stations.

SPA
DE SPA
OPS CHAN CK TEST
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES.
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES.
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES.
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES.
00/0000Z

7.1.2.2.2. Channel Checks with Non-grouped Stations.

After the initial operations channel check test (OPS CHAN CK TEST) has been sent and returned by all non-grouped participating stations, SPA Relay will maintain number continuity with the participating stations by use of periodic channel checks (CHAN CK) as often as deemed necessary and in no case will circuits or participating stations on a circuit be allowed to remain idle over 30 minutes without initiating a channel check to re-establish contact.

Non-grouped channel checks (CHAN CK) sent by SPA Relay over a single station line will be self-addressed and will be returned to SPA Relay exactly as received.

Examples

AS SENT	AS RETURNED
SPA DE SPA CHAN CK END	SPA DE SPA CHAN CK END

Non-grouped channel checks (CHAN CK) sent by SPA Relay over a multi-station line will be addressed to the participating station(s). Stations called will use a routing pilot in returning the channel checks to SPA Relay in order called.

Examples

AS SENT	AS RETURNED
COLEGE GFORKS ULASKA DE SPA CHAN CK END	SPA DE COLEGE COLEGE GFORKS ULASKA DE SPA CHAN CK END

7.1.2.2.3 Return of a channel check exactly as transmitted signifies that readability of the circuit is GOOD/FIVER. The receiving station(s) will immediately notify the control station, SPA Relay, if a perfect copy is not received. Upon notification that a station received a garbled copy or upon receipt of a garbled copy, the respective station(s) shall immediately notify the transmitting station and take immediate action to check out the respective circuit.

7.1.3 Readiness Reports.

Approximately T-120, and when required, again at approximately T-60, all participating stations are required to submit a Readiness Report to NETCON which will signify their station's status. NETCON's initial request for the Readiness Reports will be normally made after grouped and non-grouped stations/circuits have been checked out.

NETCON's Condition RED message.

ALLSTA
DE NETCON
T-120 COND RED MINIMIZE FWD READINESS REPORTS
06/1830Z FEB

Non-grouped stations response.

NETCON
DE SNTAGO
OPPLAN 2-63 GO
06/1832Z FEB

Grouped station's response.

DE COLEGE OPPLAN 2-63 GO
DE GFORKS OPPLAN 2-63 GO
DE ULASKA OPPLAN 2-63 GO
DE FTMYRS OPPLAN 2-63 GO
DE BPOINT OPPLAN 2-63 GO
DE PTARGO OPPLAN 2-63 GO

NOTE: When grouped stations are not given a separate call-up such as in the case above of ALLSTA traffic, they will answer in order called in the opening communication test. If a station is "NO GO" the reason must immediately follow.

7.1.4 Communications Countdown.

This countdown is referenced to the nominal lift-off time and contains only those periods in the countdown which require action by personnel in the Space Communications Center.

ITEM	TIME	NETWORK CONDITION	ACTION
I	T-10 Days	BLUE	Forward notification to all participating stations, NORAD, SAO, SPACETRACK, SPACE SURVEILLANCE, and SPACEWARN of the nominal launch date and time. Forward nominal Doppler frequencies to the GSFC Mission Directors Center (MOC), Pt. Arguello, California.

ITEM	TIME	NETWORK CONDITION	ACTION
II	T-7 Days	BLUE	Conduct communication exercises.
III	T-5 Days	BLUE	SPACON request special coverage on circuitry from carriers.
IV	T-5 Days	BLUE	Forward Nominal Predictions to all participating stations.
V	T-1 Day	GREEN	Forward condition GREEN to all participating stations. Forward station alert to all participating stations requesting that they be prepared to implement Opplan 2-63.
VI	T-1 Day	GREEN	Alert Chief Operator at GSFC telephone switchboard of impending operations.
VII	T-150 Min (NOMINAL)	RED	Establish Network Groups and conduct complete system test with all participating stations prior to condition RED. This test must be received perfectly by SPACON otherwise stations will not be considered ready. SPACON prove all CDC circuits by sending test.
VIII	T-120 Min.	RED	Alert RCASF and RCANY that circuits to OOMERA and JOBURG will be required to be operational until further notice. Monitor the circuit to insure readiness. Alert ACA that circuits to South American stations are to be operational until further notice. Monitor circuits to ensure readiness.

ITEM	TIME	NETWORK CONDITION	ACTION
IX	T-120 Min.	RED	Forward condition RED to all participating stations. Impose MINIMIZE at this time.
X	T-120 Min.	RED	Forward request for station readiness reports to all participating stations.
XI	T-60 Min.	RED	Forward request for station readiness reports to all participating stations.
XII	T-30 Min.	RED	Terminate transmissions on all circuits except the continuing count from PTARGO.
XIII	Lift-Off	RED	Lift-Off. NETCON keeps Group I informed of progress, SPACON informs all others.
XIV	T + 15 Min.	RED	Control of Group I reverts to SPACON who will adjust or terminate special launch groupings and conditions as needed.

7.1.5 Data Transmission.

During the launch and early orbit phase, all tracking data received in the Space Communications Center will normally undergo prescribed logging and filing. A page print copy of the data messages will then be forwarded to the Early Orbit Determination Group for processing and routing to the appropriate recipient(s) for orbital computations. The teletype tape containing the data message will be sent to the Minitrack Data Section over the CDC line designated for this purpose. During the normal phase, tracking data will be handled in the standard prescribed manner.

7.2 NORMAL PHASE - CONDITION BLUE.

All stations will revert to standard operating procedures at the termination of the launch and early orbit phase. This will be indicated by the setting of condition BLUE.

8.0 COMPUTING CENTER OPERATIONS.

The Data Systems Division will be responsible for pre-launch and post-launch orbital computations and station predictions.

8.1 NOMINAL PRE-LAUNCH PREDICTIONS.

8.1.1 Input.

Nominal injection data will be taken from the Detailed Test Objectives as published by the Astronautics Division, Chance Vought Corporation.

8.1.2 Output.

8.1.2.1 Orbital elements, equator crossings, latitude and meridian crossings, predicted observations, and topocentric coordinate data for the first three days will be required as indicated in Table 8-1.

8.1.2.2 Prediction World Map.

The Prediction World Map should be for the first three days. Nominal prediction world maps will be required as indicated below.

Operations Branch	2 copies
Project Manager	1 copy
Project Scientist	1 copy
Ground Systems Manager	1 copy
Dr. H. H. Plotkin	1 copy

All pre-launch nominal predictions should be available no less than fourteen days prior to launch and should be recomputed prior to launch if any changes occur in the trajectory.

8.1.2.3 Mutual Visitility Times.

Mutual visibility times between the Experimenters stations and the GSFC Satellite Tracking and Data Acquisition Network stations listed in Table 8-2 should be computed for a three day period following launch and should be available at least fourteen days prior to launch. The mutual visibility times will be for those S-66 passes in which the Experimenters stations, with a 30 degree minimum elevation angle, are also visible by the Space Tracking and Data Acquisition Network stations. The mutual visibility times will be distributed as indicated below.

Operations Branch	2 copies

8.1.2.4 GSFC Bulletin Predictions.

The GSFC Bulletin Predictions should be computed for the first two weeks following launch and should be available at least fourteen days prior to launch. The GSFC Bulletin Predictions will be distributed 10 days prior to launch as indicated in Table 8-3.

8.2 POST-LAUNCH REQUIREMENTS.

8.2.1 Input.

The following types of tracking data will normally be used in orbital computations.

8.2.1.1 Launch and Early Orbit Phase.

8.2.1.1.1 Minitrack Direction Cosine Data.

8.2.1.1.2 Radar Data (azimuth, elevation, and slant range).
NOTE: FPS-16 data from PRM will be in the Mercury format.

8.2.1.1.3 Space Surveillance Data.

8.2.1.1.4 Optical Data.

8.2.1.1.5 Doppler Data.

8.2.1.2 Normal Phase.

Minitrack Direction Cosine Data.

8.2.2 Output.

8.2.2.1 Orbital elements, equator crossing predictions, latitude and meridian crossing predictions, and predicted observations will be required as indicated in Table 8-4.

TABLE 8-1

STATION	ORBITAL ELEMENTS	EQUATOR CROSSINGS	LATITUDE & MERIDIAN CROSSINGS	PREDICTED OBSERVATIONS	TOPOCENTRIC COORDINATE DATA
Antofagasta, Chile	X	X	X	X	
Blossom Point, Maryland	X	X	X	X	
College, Alaska	X	X	X	X	
E. Grand Forks, Minnesota	X	X	X	X	
Fort Myers, Florida	X	X	X	X	
Goldstone, California	X	X	X	X	
Johannesburg, S. Africa	X	X	X	X	
Lima, Peru	X	X	X	X	
Quito, Ecuador	X	X	X	X	
Santiago, Chile	X	X	X	X	
St. Johns, Newfoundland	X	X	X	X	
Winkfield, England	X	X	X	X	
Woomera, Australia	X	X	X	X	
APL/Howard County, Maryland	X	X		X	
Austin, Texas				X	
Las Cruces, New Mexico				X	
Lasham, England				X	
Anchorage, Alaska				X	
Misawa, Japan				X	
Pretoria, S. Africa				X	
Smithfield, Australia				X	
South Point, Hawaii				X	
San Jose Dos Compos, Brazil				X	
San Miguel, Phillippines				X	

STATION	ORBITAL ELEMENTS	EQUATOR CROSSINGS	LATITUDE & MERIDIAN CROSSINGS	PREDICTED OBSERVATIONS	TOPOCENTRIC COORDINATE DATA
Gilmore Creek, Alaska* (ULASKA)	X	X			X
Launch Pad**				X	
MAB (Pt. Arguello, California)**	X	X		X	
Prince Albert, Saskatchewan	X			X	
Wallops Island, Virginia	X	X		X	
Palo Alto, California	X	X		X	
Boulder, Colorado	X	X		X	
Urbana, Illinois	X	X		X	

NOTE: Printouts of all of the above predictions, except topocentric data, are required by NETCON.

*These predictions should be computed for the launch phase and the first two orbits thereafter.

**These predictions will be sent to the GSFC Field Projects Branch Representatives at PMR for Range Coordination.

8.2.2.2 Prediction World Map.

Prediction World Maps will be required as indicated below.

Operations Branch	2 copies
Project Scientist	1 copy
Data Processing Branch	1 copy
Dr. H. H. Plotkin	1 copy

8.2.2.3 The orbit of the S-66 spacecraft will be "up-dated" weekly unless conditions require otherwise. Prediction information will be computed weekly in accordance with a schedule mutually agreeable to the GSFC Network Controller and the Computer Operations Branch and will be for a one week period unless the orbital conditions are such that the predictions are not sufficiently accurate.

8.2.2.4 Mutual Visibility Times.

Mutual visibility times between the Experimenters stations and the GSFC Space Tracking and Data Acquisition Network stations listed in Table 8-2 will be computed weekly for a one week period and will be distributed as indicated below.

Operations Branch	2 copies

8.2.2.5 GSFC Bulletin Predictions.

The GSFC Bulletin Predictions will be computed weekly for a two week period and will be distributed as indicated in Table 8-3.

8.2.2.6 Interim-Definitive World Maps.

8.2.2.6.1 The Interim-Definitive World Maps should be for two week periods and should be printed no later than two weeks after the period covered. Distribution will be as indicated below.

Project Scientist	1 copy
Operations Branch	1 copy
Data Processing Branch	1 copy

8.2.2.6.2 Microfilmed (16 mm) Interim-Definitive World Maps should be for two week periods and should be microfilmed no later than three weeks after the period covered. Distribution will be as indicated in Table 8-3.

TABLE 8-2

EXPERIMENTER'S STATIONS	SPACE TRACKING AND DATA ACQUISITION NETWORK STATIONS
Palo Alto, California	Antofagasta, Chile
Honolulu, Hawaii	Blossom Point, Maryland
Boulder, Colorado	College, Alaska
Huancayo, Peru	E. Grand Forks, Minnesota
University Park, Pennsylvania	Fort Myers, Florida
Adak, Alaska	Lima, Peru
Baker Lake, Canada	Goldstone, California
Houghton, Michigan	Quito, Ecuador
Urbana, Illinois	Santiago, Chile
	St. Johns, Newfoundland
	Winkfield, England

TABLE 8-3

NAME	COUNTRY
Mr. Sandro Radicella	Argentina
Mr. K. Jones	Australia
Dr. G. H. Munro	Australia
Prof. H. C. Webster	Australia
Dr. B. H. Briggs	South Australia
Dr. C. N. Gerrard	South Australia
Prof. O. Burkard	Austria
Dr. Fernando de Mendonca	Brazil
Dr. A. Kavadas	Canada
Dr. W. J. G. Beynon	England
Dr. B. Burgess	England
Dr. K. W. Weekes	England
Dr. A. F. Wilkins	England
Dr. G. N. Taylor	England
Dr. J. W. King	England
Dr. K. Rawer	Germany
Prof. J. Bartels	Germany
Prof. Dr. W. Dieminger	Germany
Mr. H. Kaminski	Germany
Prof. Dr. Christian Munther	Germany
Rev. J. R. Koster (PhD)	Ghana
Prof. Michel Anastassiades	Greece
Prof. A. N. Hunter	Kenya
Dr. K. R. Ramanathan	India
Dr. R. G. Rastogi	India
Dr. Y. V. Somajayulu	India
Dr. E. B. Rao	South India
Prof. Nello Carrara	Italy
Prof. P. F. Checcacci	Italy
Dr. Yoshiaki Nakata	Japan
Dr. J. E. Titheridge	New Zealand
Dr. J. Mawdsley	New Zealand
Mr. J. Frihagen	Norway
Dr. B. Landmark	Norway
Mr. G. S. Kent	Nigeria
Dr. E. Galdon	Spain
Dr. A. Romana, SI	Spain
Dr. Ludwik Liszka	Sweden
Dr. M. Golay	Switzerland

NAME	COUNTRY
Dr. J. Papet-Lepine	France
Prof. E. Vassy	France
Dr. J. Aarons	United States
Dr. P. R. Arendt	United States
Mr. Clifford M. Beamer	United States
Dr. W. W. Berning	United States
Dr. John P. German	United States
Dr. O. K. Garriott	United States
Prof. Robert E. Houston, Jr.	United States
Dr. E. Mechtly	United States
Dr. Byron C. Potts	United States
Mr. Fred A. Rdorique	United States
Dr. W. J. Ross	United States
Prof. George W. Swenson, Jr.	United States
Dr. Gary S. Sales	United States
Dr. James D. Lawrence, Jr.	United States
Mr. Robert S. Lawrence	United States
Mr. Leo J. Blumle	United States

TABLE 8-4

STATION	ORBITAL ELEMENTS	EQUATOR CROSSINGS	LATITUDE & MERIDIAN CROSSINGS	PREDICTED OBSERVATIONS
Antofagasta, Chile	X	X	X	X
Blossom Point, Maryland	X	X	X	X
College, Alaska	X	X	X	X
E. Grand Forks, Minnesota	X	X	X	X
Fort Myers, Florida	X	X	X	X
Goldstone, California	X	X	X	X
Johannesburg, S. Africa	X	X	X	X
Lima, Peru	X	X	X	X
Quito, Ecuador	X	X	X	X
Santiago, Chile	X	X	X	X
St. Johns, Newfoundland	X	X	X	X
Winkfield, England	X	X	X	X
Woomera, Australia	X	X	X	X
Wallops Island, Virginia	X	X		X
APL/Howard County, Maryland	X	X		X
Palo Alto, California	X			X
Boulder, Colorado	X			X
Urbana, Illinois	X			X

NOTE: Printouts of all of the above predictions are required as indicated below.

Operations Branch 2 copies

9.0 DATA PROCESSING.

The analog magnetic tapes from the Space Tracking and Data Acquisition Network stations containing S-66 data, telemetered and beacon, will be forwarded to the Data Processing Branch, Space Data Acquisition Division, GSFC, for evaluation, processing, and reduction.

Limited processing and reduction in the form of quick-look status information will be a joint responsibility of the Operations and Support Division, GSFC, and the Johns Hopkins University, Applied Physics Laboratory.

9.1 DATA EVALUATION.

All analog tapes recorded by the STADAN stations will be forwarded to:

Analog Tape Library, Code 565
Goddard Space Flight Center
Greenbelt, Maryland, U.S.A.

for reception and cataloging by the Analog Tape Library and quality checking prior to processing and reduction. Tapes will be evaluated on a sampling basis to provide feedback for the STADAN stations.

Three tapes from each station will be evaluated as soon as practicable after receipt for appraisal of station performance. A report concerning the quality of each station's tapes will be submitted to the Head, Operations Branch, Operations and Support Division, no later than 72 hours after receipt of the third tape from each of the stations. An interim report will be submitted if a major discrepance is noted.

Each week the latest tape received from each station will be run through the tape evaluation procedure for a detailed examination of quality and for preparation of a composite weekly station telemetry report.

9.2 DATA REDUCTION.

9.2.1 Telemetry Data.

After tape evaluation, the magnetic tape containing the S-66 telemetered data will be processed through 10.5 Kc and 5.4 Kc discriminators, resulting in an analog voltage output. Strip charts and/or oscillographic records containing the PDM/PAM telemetered data will then be made of the resulting analog voltages. Further reduction will be in the form of status data, magnetometer data, and electron density data.

9.2.1.1 Status Data.

Status data, certain critical channels of the telemetered data, will be supplied to the S-66 Project Office for the purpose of monitoring, evaluating, and maintaining a history of the performance of the spacecraft. This data will be supplied on a weekly basis in a tabular form expressed in engineering units.

9.2.1.2 Magnetometer Data.

Magnetometer data, channels 12, 13, 14, and 15 of the PAM commutator, will be reduced along with the status data. In addition, magnetometer data recorded during certain expected magnetic storms following solar flares of class two (2) or larger will be reduced. This data will be made accessible in a reduced form to any of the prime investigators.

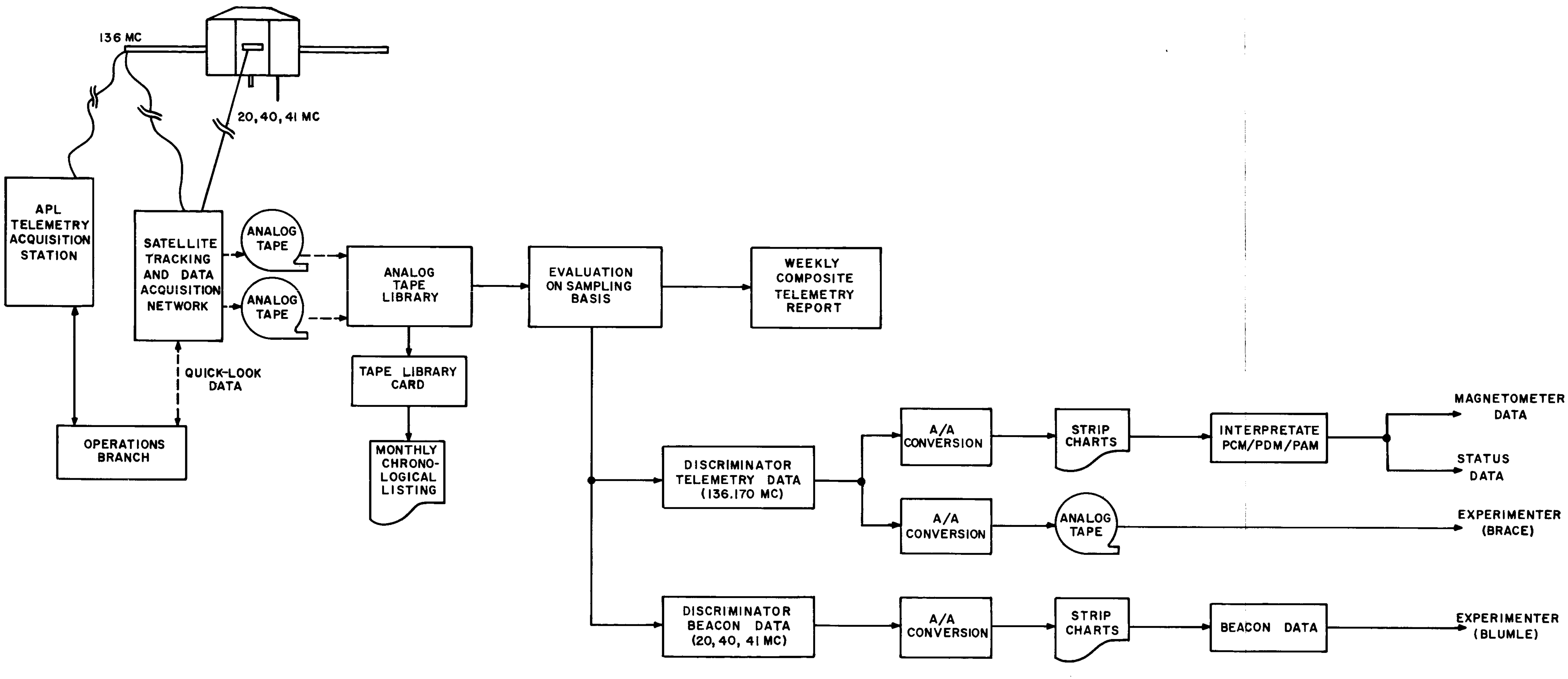
9.2.1.3 Electron Density Data.

Upon completion of the status and magnetometer data reduction requirements, the Data Processing Branch, GSFC, will forward on a loan basis, the S-66 magnetic tapes containing electron density data to the Physics Branch, GSFC, for the reduction of the electron density data.

9.2.2 Beacon Data.

Due to the signal's characteristics, the magnetic tape (1/4 inch) containing the beacon data will be processed through special purpose discriminators resulting in six outputs (0.1 to 10 volts). These outputs will in turn be connected to the input of a six channel hot stylus recorder and produce an oscillographic chart of the beacon signals. The chart will then be forwarded to the Planetary Ionospheres Branch, GSFC, for further reduction and analysis.

NOTE: All special purpose equipment required to reduce the beacon data will be supplied and maintained by the Planetary Ionospheres Branch.



S-66 DATA FLOW CHART

FIGURE 12

BIBLIOGRAPHY

1. Project Development Plan, Polar Ionosphere Beacon Satellite, S-66, Revised March 26, 1963.

2. NASA Scout NS 17500 Operations Requirements, S-66 Mission, February 25, 1963.

3. Instruction Manual, Minitrack Digital Command Encoder (S-B3339), February, 1962.

DISTRIBUTION LIST

Aarons, J.	1
Anastassiades, M.	1
Anderson, D. W.	1
Arendt, P. R.	1
Aucremanne, M. J.	5
Bartels, J.	1
Beamer, C. M.	1
Benham, T. A.	1
Berbert, J. H.	1
Berning, W. W.	1
Beynon, W. J. G.	
Bianco, D. R.	6
Blumle, L. J.	1
Bodin, W. J.	1
Bourdeau, R. E.	20
Brace, L.	1
Bridger, J. B.	2
Briggs, B. H.	1
Brown, L. W.	1
Buckley, E. C.	5
Burgess, B.	1
Burkhard, O.	1
Byrd, V. H.	1
Carbaugh, J. P.	9
Carrara, N.	1
Checcacci, P. F.	1
Chrisman, H.	1
Churgin, A. B.	2
Cortwright, E. M.	1
Covington, O. M.	1
Creighton, V. J.	6
Creveling, C. J.	1
Cummings, C.	1
de Mendonca, F.	1
Dennis, M. G.	1
Dieminger, W.	1
Enders, J.	1

Ferris, A. G.	1
Fielder, D.	3
Fivehouse, H. J.	1
Fleming, J. J.	2
Friel, F. J.	1
Frihagen, J.	1
Galdon, E.	1
Garriott, O.K.	2
German, J. P.	1
Gerrard, C. N.	1
Goett, H. J.	2
Golay, M.	1
Gorman, T.	1
Gridley, D. H.	4
Habib, E. J.	1
Hagen, J. P.	1
Hagerman, E.	1
Hartman, E. P.	1
Heller, N. R.	5
Hess, W. M.	1
Hicks, R.	5
Hoff, H. L.	1
Hunter, A. N.	1
Houston, R. E.	1
Jones, K.	1
Kaminski, H.	1
Kavadas, A.	1
Kent, G. S.	1
King, J. W.	1
Koster, J. R.	1
Landmark, B.	1
Lawrence, J. D.	1
Lawrence, R. S.	2
Liszka, L.	1
Looney, C. H.	1
Lucas, T. V.	1

Martin, F. T.	10
Mathews, C. W.	3
Mawdsley, J.	1
Mazur, D.	1
McAaron, K. A.	1
Mechtly, E.	1
Mengel, J. T.	3
Meredith, L. H.	1
Munro, G. H.	1
Munther, C.	1
Nakata, Y.	1
Neilon, J. J.	3
Newell, H.	2
Papet-Lepine, J.	1
Parker, D. A.	1
Parks, R.	1
Peterson, C. M.	28
Phillips, C. M.	1
Plotkin, H.	2
Potts, B. C.	1
Purcell, J.	1
Radicella, S.	1
Rao, E. B.	1
Ramanathan, K. R.	1
Rastogi, R. G.	1
Rawer, K.	1
Rettie, R. S.	2
Rodrique, F. A.	1
Romana, A.	1
Rosenberry, J. W.	10
Ross, W. J.	2
Sales, G. S.	1
Schroeder, C. A.	1
Schwartz, J.	5
Shapiro, H.	3
Shea, J. T.	1
Sheppard, D. C.	2
Simas, V. R.	1
Siry, J.	2
Snyder, S. A.	1
Somajayulu, Y. V.	1

South, J. F.	2
Sparks, B.	1
Stelter, L. V.	1
Stewart, D.	1
Stoller, M. J.	1
Stotler, H. J.	1
Stout, C. M.	1
Stroble, R. R.	1
Swenson, G. W.	2
Taylor, G. N.	1
Titheridge, J. E.	1
Townsend, J. W.	6
Turnbull, H. A.	1
Tysdal, R. M.	1
Vaccaro, M. J.	1
Vassy, E.	1
Wasielewski, E. W.	1
Webster, H. C.	1
Weekes, K. W.	1
Wilkings, A. F.	1
Woodward, V. M.	1
GSFC News	1
GSFC Library	2
Public Information Office	3
Security Office	1
Spacecraft Controller	5
Network Controller	5
Operations Coordinator	5
Head, Telemetry Section	1
Spacetrack R&D Facility	2
NAV SPACURFAC	3
NORAD	5
SPADATS	3
Army Map Service	2
ADLADE	2
COMELH	2
Prince Albert Radar	2